THE LEARNER'S INTUITION:

HARNESSING THE POWER OF INTUITIONS DURING CREATIVE AND COLLABORATIVE ACTIVITIES

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Submitted to the faculty of the University Graduate School in partial fulfillment of the

requirements for the degree Doctor of Philosophy in the School of Education,

Indiana University, Bloomington

April 2015

Accepted by the Graduate Faculty, Indiana University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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August 6, 2014

I would like to dedicate this dissertation to my wife, Charmaine, and son, Evan. Without their support, love and infinite patience during this whole process, I would not have been able to complete this project. Both of you mean the world to me and I love you more every day. Thank you for all your love and patience!

To my new colleagues at St. John's University for their understanding as I undertake both a new job and finishing this dissertation. I would especially like to thank Dr. Margot Ely, Professor Emerita at New York University who patiently read this document from front to back and provided such wonderful feedback and pushed my thinking into new directions.

To Jeanne Bamberger who said to me during a conversation "…it all goes back to kids making things". This, as well as her approach to music learning and understanding, have had such a profound effect on me.

To Dr. Drew C. Appleby who taught me the words to live by.

To my friends in the School of Education at Indiana University. Through all the projects, assignments, and classes, your feedback over the years has been instrumental in shaping my thinking. An extra special thanks to Asmalina "Lina" Saleh and Kate Shively who have supported me in this endeavor with their wonderful feedback and attentive ears.

And last, but certainly not least, my research committee. To Dr. Joyce Alexander who has kept me grounded and has pushed me when times looked their most bleak. To Dr. Katy Strand who has provided such wonderful feedback on how to engage both a learning sciences and music education audience. To Dr. Joshua Danish who has the unbelievable talent of asking the right questions to produce the most understanding and I only hope I can engage my students in the way that you have me throughout the years. And finally, to Dr. Kylie Peppler who has shown me unwavering support by not only allowing me to pursue my passion in music but exposing my work and ideas to major contributors in the field. We started this journey at the same time with you being a new faculty member and me being your first student. You have pushed, pushed again, pushed further, and still push and for that, it has made me a better scholar, academic, and professional. No words can express my gratitude.

Michael P. Downton

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Intuitions have received little attention in learning and education largely due to the difficulty in defining what intuitions are and their potential benefit (or detriment) to learning. The research on intuitions has been encouraging, yet the methods employed to study these intuitions often involve learners—some with considerable background and/or prior domain knowledge—expressing their thinking, *a priori*, about some phenomena they have encountered. If, however, intuitions help individuals make sense of unfamiliar and new phenomena encountered in the world, then steps should be taken to encourage learners to use their intuitions as they encounter these phenomena.

The findings in this dissertation suggest that even over small amounts of time, young children can think and produce materials that are beyond what was initially thought to be developmentally appropriate. Further still, engaging young learners in a discourse that values intuitions is important and activities grounded in practices that encourage children to be actively involved in making a tangible artifact helps in the construction of knowledge. Furthermore, curricular designs grounded in a constructionist theory of learning and teaching and mediated by technology may be advantageous for music educators because they encourage students to engage in what musicians do (e.g., create music).

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CHAPTER ONE

Introduction

"For it is intuition that improves the world, not just following the trodden path of thought."

-Albert Einstein, *Einstein and the Poet.*

Researchers and theorist concerned with education have surmised that intuitions are not merely a set of skills that are unconscious, but that intuitions are a form of knowledge based on previous experience (Bruner 1977; diSessa, 1993; Fischbein, 1982)[1]. This is significant because it gives intuitions a legitimacy, especially in learning and knowing, that has not previously been presented. I specifically define an intuition as a mechanism that connects pieces of knowledge so that learners can make sense of the world around them. Metaphorically, this can be thought of as two puzzle pieces connected by a string; the string (e.g., the intuition) is the mechanism to bring these knowledge pieces together. Intuitions—also known in the literature as misconceptions, preconceptions, and naïve beliefs—are largely not supported by teachers in a classroom (Smith, diSessa, and Roschelle, 1994; Chiu, 1996). This could be a result of teachers engaging in traditional classroom discourse practices that only seek correct answers (Lemke, 1990) or teachers have not been given the opportunity to engage with students' intuitions that produce positive learning experiences.

Three overarching themes exist in the literature in regard to the importance of intuitions. First, it is important to allow learners to express their thoughts (e.g., intuitions) through the active exploration of the domain (Chi, Bassok, Lewis, Reimann, and Glaser, 1989; diSessa,

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[1] This is a very general overview of how intuitions have been portrayed in the literature. Chapter Three delves much deeper into intuitions in learning and how these views inform the current research presented in this dissertation.

1993; Smith, diSessa, Roschelle, 1994; Sherin, 2006; Bamberger, 1996). There is considerable research that prompting learners (e.g., asking them questions) is good for learning (c.f., Chi, et al., 1989; King, 1994; Lemke, 1990). What is not clear in the current literature is the best way to encourage this exploration from a pedagogical and curricular perspective. Pedagogically speaking, a determination needs to be made about the types of questions that encourage intuition use.

The second theme is the curricular design approaches that should be implemented in order to encourage a deep and sophisticated engagement with the domain. While it would stand to reason that activities that have a specific goal would be advantageous for learners, especially those without the formal background knowledge of the domain, it is contradictory to the constructionist approach being taken in this dissertation. The research in this dissertation is grounded in the idea that learning happens best when the learner is given the opportunity to make something (Papert, 1980; 1991). Furthermore, if the intended goals of the activity are incongruent with the goals the learner has, it makes learning difficult (Papert, 1980; Schön, 1983). The relationship between the specific types of design activities and a learner's engagement and learning in the domain is underspecified in the research concerned with intuitions and constructionism. The research in this dissertation addresses this gap by investigating the types of activities (e.g., goal-oriented vs. open-ended) and the impact on domain learning and engagement.

Finally, it is unclear in the literature whether these types of intuitive driven activities impacts the creativity of the artifact being produced. The research conducted in this dissertation provides empirical support by evaluating the artifacts (e.g., compositions) using a general assessment utilizing three dimensions of creativity.

The research proposed in this dissertation contends that the usefulness of intuitions for learning lies in an interaction between how the teacher/practitioner elicits these intuitions, how the learner expresses their intuitions via reflection, and the artifact being produced and the impacts of the type of reflection (i.e., reflection-in vs. reflection-on-action) as well as how the design activities are constructed (goal-oriented vs. open-ended). To investigate these issues, the research in this dissertation is guided by the following five questions explored over three interrelated papers:

1. What role does the practitioner have in scaffolding intuitive explanations?
2. What types of questions elicit engagement within the structural musical ladder?
3. When fourth-grade students engage in both reflection-in and on-action, which type of reflection seems to promote greater domain engagement? How are the domain specific responses (i.e., advanced musical concepts) distributed during each activity?
4. What impact does the type of activity have on student's sophisticated discourse in the domain?
5. Based on a standard assessment of music composition, do student compositions reflect a greater sense of aesthetic appeal, craftsmanship, and creativity at specific time points?

I ground my study in the domain of music because (1) music is largely undervalued/non-existent in the Learning Sciences literature, and (2) our experiences with music are vast and the intuitions we have provide a fruitful area for further research. Using audio/video of classroom interactions, written journals made by the students, and the music compositions of the students, both qualitative and quantitative methodologies were employed to interpret the data. Analysis of the data was guided by a constructionist theory of learning and teaching (Papert, 1980; 1993; Kafai, 2006; Peppler and Kafai, 2007) and further influenced by sociocultural factors of learning (Vygotsky, 1978).

Guiding Theory

Constructionism is a theory of learning that builds off the Piagetian idea that children are active and motivated constructers of their own knowledge and that this construction happens best when the learner is making a tangible artifact they find meaningful (Papert, 1980; 1991; 1993; Kafai, 2006). Furthermore, it is through this making of something that the learner develops powerful ideas about how things work in the world (Papert, 1980). These powerful ideas help use reorganize and restructure our knowledge and thus impact our learning, much in the same way an intuition can help us see the whole of a problem and guide our thinking (Bruner, 1977; Noddings and Shore, 1984).

Because learners are constructing something, they are making their internal representations more external—more concrete. This, then, gives the learner the opportunity to reflect on his or her constructions, which, for Papert (1980), is an under-utilized practice (e.g., talking about learning). So, in essence, constructionism is about making new connections to the world, by making the abstract more concrete, and by reflecting on knowledge.

Professionals in varying disciplines engage in activities that are difficult to break down into simple step-by-step directions that could be followed by a non-professional or novice. The reason is because professionals rely a great deal on their intuitions (Schön, 1987). It has also been observed that novices have intuitions (Bamberger, 2013; Bruner, 1977; diSessa, 1993; Noddings and Shore, 1984). The difficulty arises when professionals try to explain themselves—by using rules, norms, practices, and specialized language—and expect the novice learner to understand (Gee, 2003).

Schön calls this difficulty a "learning bind" (1987, p. 127) and that the best way to overcome it is for a new/novice learner to be actively engaged in an activity that includes communication relevant to the domain. The research conducted in this dissertation has been designed specifically with these ideas in mind. Specifically, the students in this dissertation were engaged in making computer-aided music compositions and in conversations with the practitioner and each other during the composition process.

Overview of the Dissertation

Chapters Two, Three, and Four of this dissertation have been set up as their own individual paper. Each of these chapters has its own abstract, introduction, background, methods, findings, and discussion section. The reason for this format is to more easily convert each chapter into its own manuscript for publication. The following sections will provide an overview of each chapter, the intended audience, and potential areas for publication (e.g., journals).

Chapter Two investigates the role the practitioner has in scaffolding students' intuitive explanations during whole-class music composition activities by documenting the interactions between practitioner and student. The intended audience for this chapter is a practitioner/teacher audience. The reason for this is that it can inform practitioners/teachers what to look for in student responses and the best ways to encourage a deep and sophisticated discourse while creating an artifact. The goal is to either publish the article in a practitioner-related journal that could include Teacher and Teacher Education or Journal of Education for Teaching.

Chapter Three involves the analysis of students' intuitive self-explanations of music phenomena both during reflection-in-action (i.e., whole class) and reflection-on-action (i.e., individual) conditions and the impact the design activities (e.g., open-ended vs. goal-oriented) have on the discourse. This chapter is intended for a Learning Sciences readership. Music and the design of creative activities in music is virtually non-existent in the Learning Sciences literature. The goal is to bring the domain of music as a viable and rich area to be further researched, and the most obvious trajectory is to publish in the Journal of the Learning Sciences.

In Chapter Four, I take a more quantitative approach to examine the change in students' music compositions over time. This chapter is intended for both researchers and practitioners because it provides empirical evidence of the impact of intuitive, music-making activities on a student's creativity. While none of the chapters are currently under review, this particular paper has been invited to be published in the College Music Symposium, a journal connected to the College Music Society (CMS) and the Association for Technology in Music Education (ATM).

CHAPTER TWO

Why Ask why? Questions to Elicit Sophisticated Intuitive Responses

Abstract

What is known about how people learn and how to best encourage learning has seen dramatic changes over the past 25 years. Learners are not passive receivers of information. Rather, learners are equipped with powerful intuitions that, when expressed in classroom discourse, help them construct knowledge essential for learning. These intuitions can promote more sophisticated thinking within a domain. The domain of music was specifically chosen for this study because the learner's exposure to music (e.g., listening) is vast and is still an under-studied area in teaching and learning. The research conducted in this chapter focuses on two fourth-grade classrooms (N = 36) engaged in a variety of collaborative, whole-class, computer music-making activities using the software Impromptu. Specifically, two research questions are addressed in this chapter: (1) What role does the practitioner have in scaffolding students' intuitive explanations?; and (2) What types of questions elicit engagement within the structural musical ladder? During the five-week curriculum, the practitioner specifically engaged the students by asking simple and open-ended questions (e.g., how?, what?, and why?) in order to elicit intuitive responses. Video/audio data sources were collected and analyzed using qualitative methods including using coding schemes and the quantifying (e.g., generating counts) of data. Findings suggest the practitioner is constantly engaging students to express their thinking and that certain questions are more effective for engaging students within the structural musical ladder. Implications for practice, policy, and research are discussed as well as the limitations of the study.

Introduction

Educators and researchers, including those in music, have long concerned themselves with the ways that people, especially children, learn and ways to encourage the best practices for learning (Bransford, Brown, & Cocking, 2000; Bruner, 1966; Eisner, 2002; Reimer, 1989; Sawyer, 2006). Certainly not in all cases, but a great deal of pedagogical approaches treated learning and teaching as mutually exclusive. More specifically, teachers imparted information to students who would retain and, hopefully, use the information when it was appropriate (Sawyer, 2006). Therefore, the accepted pedagogical practice in classrooms was for the teacher to lead the instruction and students would then receive the information (Cazden, 1986; Lemke, 1990). When students were asked to talk, teachers initiated the talk by asking a question, the student would answer, and the teacher would then evaluate the correctness of the answer (Cazden, 2001; Lemke, 1990).

The progressive education movement in the early 20th century, the cognitive revolution in the late 1960's (Gardner, 1987), the arrival of the home computer, and an interdisciplinary study of the science of learning (c.f., Bransford, Brown, & Cocking, 2000) have further advanced our understanding of complexities of learning (Sawyer, 2006). Learners are not passive receivers of information and their minds are not "blank slates" to be filled. Recent research has observed that learners have powerful intuitions that can help guide their thinking and promote learning (Bamberger, 1995; diSessa, 1993). Unfortunately, the more traditional view outlined above of a teacher reciting facts and figures and a student retaining these facts and figures—what Seymour Papert (1993) called instructionism—is still prevalent in schools today even though what is known about learning contradicts this pedagogical practice.

For example, when a learner is prompted with open-ended type questions from the teacher, the explanation the learner gives has a positive impact on learning (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Chi, De Leeuw, Chiu, & Lavancher, 1994). While the focus of the Chi et al. (1989; 1994) work was on what the learner was explaining and how “good” or “poor” the explanation was, there was no attention given to what specifically elicited a “good” or “poor” explanation. While this research and research specifically pertaining to intuitions (c.f., diSessa, 1993; Taber & García-Franco, 2010), which is explained in more detail in the following section, strengthens the idea that intuitions are important and giving learners an opportunity to explain themselves is beneficial, there are gaps in the research that need to be addressed. First is the specific role of the practitioner[2]. While it was shown that prompting students for answers was beneficial, little is known about how involved the practitioner is in promoting correct and/or domain relevant responses (e.g., good responses). The second gap is investigating the specific prompts that elicit good responses. Responses made by the students in this chapter are not differentiated by good and bad, but how the discourse that emerges, through their engagement in music composition activities, maps onto what Bamberger (1996) calls the structural musical ladder.

The purpose of this chapter is to investigate the influence a practitioner can have on a learner’s knowledge construction by asking simple, open-ended questions during whole-class and individual music making activities. Specifically, there are two questions addressed in this chapter: (1) What role does the practitioner have in scaffolding students’ intuitive explanations? (2) What types of questions elicit engagement within the structural musical ladder? Data from a five-week computer music-making class utilizing two fourth-grade classrooms (N = 36) was

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[2] The practitioner for this study was the researcher. This was decided based on the experience of similar research studies conducted by the researcher, the experience with the tools being used (e.g., Impromptu), and the recommendation from the classroom teachers where the study took place. This will be elaborated on later in the paper.

analyzed to determine what role the practitioner had on students' ability to engage in discourse that maps on to the structural musical ladder.

Background

Inquiry, Intuitions, and Intuitive Responses: A Pedagogical Framework

The ways in which learners explain their knowledge of a particular domain rests on the opportunities given to learners to provide explanations and the questions asked of the learners (Chi, et al., 1989; Chi, et al., 1994; King, 1994). One example is to give students the chance to express their understanding of a scientific theory (e.g., Newton's Laws) or ask them why or how one of these laws applies to a specific problem. However, with the focus on high-stakes testing, the typical classroom model of the teacher asking a question, the student(s) responding, and the teacher evaluating the response (Cazden, 2001) leaves the learner with little to no chance to engage in deep reflection of their knowledge beyond finding the right answer to the question (Gresalfi, 2009; van Zee & Minstrell, 1997). However, as van Zee and Minstrell (1997) have noted, the purpose of the questions should be to place responsibility on the learner, and the class as a whole, to reflect on what they know more deeply. A pedagogical approach with a focus on giving students an opportunity to express their intuitions highlights that students, especially younger and less experienced students, may know more about a topic or domain than previously thought.

Furthermore, Chi et al. (1994) suggests that when students are able to provide explanations of their knowledge, their understanding of the domain improves. The research conducted on the questions asked of learners has focused predominantly on high school and college-aged students in the sciences and math (Chi, et al., 1989; Chi, et al., 1994; diSessa, 1993; King, 1994; van Zee & Minstrell, 1997). For example, Chi, et al. (1994) specifically looked at the types of questions asked of the students solving a biology problem. Specifically these questions were germane to the subject the students were engaged in (e.g., blood flow in the heart) and designed to elicit the knowledge that was constructed after reading some text. What they found is that when students were prompted by the researcher/practitioner to provide explanations of what they know, they outperformed those learners who were not prompted (Chi, et al., 1994). King (c.f., 1994 for review) found similar results when learners were asked questions like “what happens if…?” or “why is…important?”

While these results are promising, there are gaps that need to be addressed. The first and most pressing issue is prompting versus specific questioning. Chi and colleagues (1989; 1994) simply prompted students—either by verbally asking or through designed written questions--to provide an explanation with no consideration as to the type of question that elicits better quality responses or quantitatively more responses. It is clear that prompting learners to explain themselves is beneficial, but if the concern is about giving correct and domain relevant responses, then a better understanding of what elicits these types of responses is needed. Second, understanding the specific ways (e.g., types of questions) teachers elicit intuitive responses in students can help the students reflect on their learning. Simply prompting the student for responses is not sufficient. The research in this chapter investigates the specific types of questions asked by the teacher and the responses given by the student.

Understanding what elicits a “good” response from the learners is the central focus of the study in this chapter. However, there needs to be an understanding of what constitutes a “good” response. Chi and her colleagues (1989; 1994) used criteria ranging from quality of the response that included dimensions of correctness and/or specific content knowledge. Since these studies included older, college-aged students (Chi, et al., 1989) and middle school (8^{th} grade) students

(Chi, et al., 1994), the background knowledge may have some impact on the quality of the response. The study conducted in this chapter promotes the idea that it is not domain specific background knowledge that is important, but rather the learner's intuition about a phenomenon that is important. This is because the intuition can help the learner make sense of new information and help guide problem solving (Bruner, 1977; diSessa, 1993; Fischbein, 1982; Noddings & Shore; 1984).

Our intuitions have a great impact on how we approach and explain phenomena in the world (Bruner, 1977). Intuitions in any domain—math, science, the arts—help us make sense of how the concepts function in the world. Intuitions, however, are not complete representations or knowledge structures, but contain bits of incomplete structures that, when put to use, can help us approach and solve problems (Bruner, 1977; diSessa, 1983; 1993; Fischbein, 1982; Noddings & Shore, 1984). diSessa (1983) claimed people have a sophisticated "sense of mechanism" in which we know how things work in the world. Within this sense of mechanism are incomplete knowledge structures called phenomenological primitives (and frequently called "p-prims"). They are phenomenological because we experience them in the world, and they are primitive because they need no further explanation (diSessa, 1983).

I approach intuitions in a similar manner. By that I mean intuitions, in the context of music, are knowledge structures that are activated through experiential use (e.g., listening). While the link to specific formalism (e.g., chord progressions, scales) may not be known, the intuitions are powerful building blocks to better understand these formalisms. This distinction lines up with Bamberger's (1996) ideas that intuitions are meaningful perceptual units (e.g., what we pay attention to), are highly contextual, and are embodied in our actions (e.g., playing air guitar). The purpose of this chapter, however, is to not dissect specific musical intuitions in the same way diSessa (1993) parsed out physics related intuitions (e.g., Ohm's P-Prim) but to promote a pedagogical approach that encourages learners to use and elaborate on their intuitions. This is accomplished by allowing learners to talk while they are engaged in a music making activity. This talk is analyzed and mapped onto the structural musical ladder (Bamberger, 1996). Furthermore, the talk is encouraged through question and answer interactions between teacher and student and student and student. The ideas that emerge through this talk are then taken up and used in accomplishing the task at hand (e.g., building a tune).

The research on what musically untrained children and adults intuitively know about music is extensive (c.f., Bamberger, 1996; Swainwick & Tillman, 1986; Wiggins, 2009). The general consensus is that children know more about music than they are given credit for and that approaches need to be made to understand this knowledge and how it is used. Recent research suggests that further investigation of how children's invented discourse (e.g., invented music vocabulary) helps them construct their musical knowledge is needed (Wallerstedt, 2013).

Unfortunately, there is incongruence between how the practitioner communicates their expertise and how the learner interprets this communication (Schön, 1983). This breakdown in communication causes confusion, frustration, and disengagement in both learning and teaching. Gee (2003) expands on this notion and suggests that there are two types of languages that are going on in a school environment: vernacular and specialized languages. Vernacular language is the type of discourse that happens in most everyday conversations while specialized language involves specific vocabulary pertinent to the domain being discussed. Problems arise when learners do not know how to use or do not understand the specialized language.

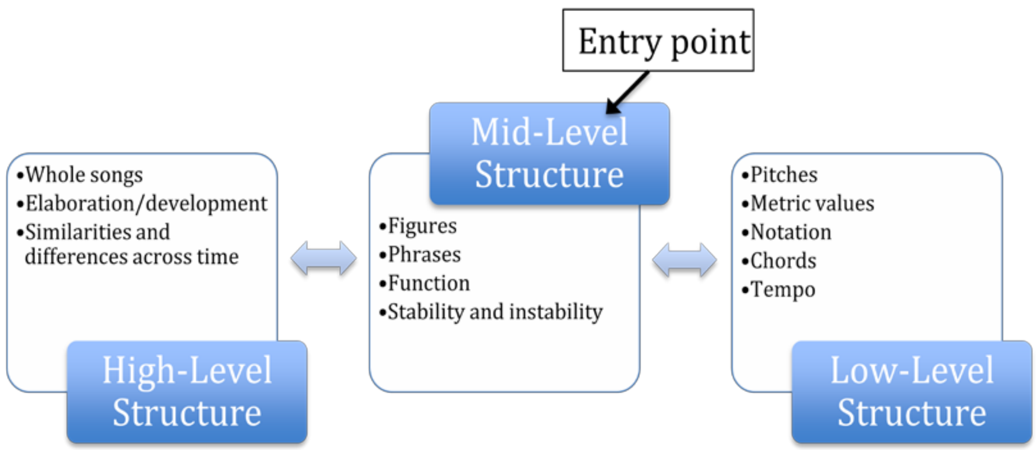
Learning music encounters the same discourse language related problems. With its nuanced symbol systems, vocabulary, and performance objectives, novice learners experience a disconnect while teachers look for only an understanding of these music literacy concepts (NAfME, 2013). Research has shown that even the most novice music learner has a very sophisticated understanding of how music functions (Bamberger, 2013; Downton, Peppler, & Bamberger, 2011). Expanded further, Bamberger (1996; 2000; 2003) notes that learners do not understand music from a nuanced approach. For example, they do not understand notation or melodic/chord structures independent of the context of a melody or tune. What they do understand (and perceive) is larger structures of music where the melody and rhythm play a specific role within a given context (e.g., a tune).

Bamberger has explained in several of her works (c.f., 2013) that even the novice music learner (child or adult) concentrates on the meaningful patterns and structures that they hear and thus construct an understanding of how those patterns function. While teachers are looking for a match to the traditional music conventions (e.g., reading, writing, or performing), they are "…making some critically mistaken assumptions about our students' healthy musical intuitions - what they know how to do already" (Bamberger, 1996, p. 34). Researchers who have investigated intuitions suggest that (1) if intuitions are not encouraged while learning, they may be neglected later on at a time when they could be helpful (Bamberger & diSessa, 2003), and (2) teachers should know about intuitions and how to model different ways of explaining phenomena (intuitively) that could lead to expert understanding later on (diSessa, 1993). The research in this chapter is seeks to understand the discourse that emerges through music composition activities and how and if this discourse reflects a sophistication that was not otherwise taught.

Responses and the structural musical ladder

The pioneering of work of Jeanne Bamberger (2013) has provided the greatest insights into musical intuitions and their importance in learning as well as laying the groundwork for using the computer as a music learning tool rather than simply a production or consumer tool. She suggests that what novice music learners already know and know how to do is within mid-level structures of the structural musical ladder (SML) (see Figure 1).

Figure 1. The Structural Musical Ladder. Adapted from Bamberger (1996, p. 45)



More specifically, when learners are able to engage with music in a way that promotes what they already know and know how to do (e.g., mid-level structures), they can move to both higher and lower level structures more easily (Bamberger, 1995; 1996; 2003).

However, pedagogical practices in music rarely involve activities that allow for students to begin with what they already know how to do (Bamberger, 1996). When teachers only concern themselves with symbol systems (e.g., music notation) as a means of assessing what is correct or incorrect (e.g., looking for specialized language), they may be missing some important and useful knowledge the learner has and how to cultivate that knowledge further (Bamberger, 1996; 1999; Wiggins, 2009). The work presented here encourages students to express their intuitions while explicitly focusing on the specific types of questions that elicit the different types of responses. Being able to differentiate the most effective types of questions (e.g., those that promote more movement up and down the SML) could enhance pedagogical practice.

Guiding Constructionist Theory: A Theory of Learning and Teaching

There are many different pedagogical approaches used in music education today, with the main four being Kodály, Orff, Suzuki, and Dalcroze. Each affords a unique approach to teaching and learning music (e.g., dancing, performing, listening) with specific aims and goals for the learner (Mark, 1996). However, the research conducted in this chapter centers around a more general and contemporary theory of learning known as constructionism. Constructionism (Papert, 1980; 1991; 1993; Kafai, 2006) reflects much of Piaget's constructivist (with a "V") understandings that children are active learners who build their knowledge from their experiences in the world. Additionally, this learning happens best when the learner is engaged in the act of externalizing these internal representations through the design and sharing of public artifacts (in this case, a music composition). However, this construction process does not happen in a vacuum, devoid of any sort of guidance.

Teachers, as well as books or other materials, are not viewed as simply transmitters of information in a constructionist environment. Papert (1980; 1993) envisioned a pedagogical approach that centered on the learner engaged in making something, via the computer (e.g., programming). The computer is transformed into an object to think with; that is, the learner uses it as an extension of their thinking (Papert 1980). This is a contrast to the common "transfer of knowledge" from teacher to student model that has persisted in schools throughout history. This might be construed that the teacher is not integral in a constructionist environment. But Papert (1980; 1993) and others (c.f., Kafai, 2006) consider the role of the teacher in a constructionist environment is just as important as the tools (i.e., the computer) the learner uses to construct and reformulate their knowledge structures. Papert even addressed the issue of teaching by stating that "...the goal is to teach in such a way as to produce the most learning for the least teaching" (Papert, 1993, p. 139). What this means is that teachers and practitioners need to guide the learning process in a way that leads to more learning and knowledge construction.

This is accomplished in a constructionist environment by making the abstract more concrete (Kafai, 2006; Papert, 1980). By this, Papert (1980) insists that when children are able to, for example, program a computer, their abstract thinking becomes concrete through their interactions with the computer. The knowledge that is constructed or reformulated becomes personal to the child. They are able to reflect on the artifact (e.g., computer program) and thus reflect on their learning, which is key in a constructionist learning environment (Papert, 1980; 1991; 1993). Another way to make the abstract more concrete is to allow children to talk while engaged in an activity (Vygotsky, 1978).

Constructionism is not simply about the artifact being produced, but also the pedagogical efforts to elicit meaningful knowledge construction. The central focus of this chapter is the practitioner and how they scaffold and elicit different intuitive responses from the learners during a music making activity.

Encouraging Intuitions in a Constructionist Environment

As noted, constructionism is a theory of learning that posits when children are able to engage in making something (e.g., a music composition) that is meaningful to them and it changes how they view the domain, their place within the domain and, moreover, the world (Papert, 1980; Kafai, 2006). While the artifact produced (e.g., the musical composition) is an important piece to understand what the learner is learning about, their discourse (e.g., how they talk about what they are doing) is just as important (Downton, Peppler, & Bamberger, 2011). This talk is another artifact that, according to Wells (1999), becomes shareable with others and allows the learner to reflect on his or her “understanding in externalized form and to respond to it in the same way as do other participants” (p. 107). If teachers and practitioners can better understand how to engage students in discourse that promotes the use of intuitions coupled with making an artifact, it may help in devising new pedagogical practices that will help students learn and help teachers assess student progress.

Why Music Composition?

Computer aided music composition was used in this study because it complements Papert’s (1980) notion that (1) technological tools, like the computer, can transform a learner’s knowledge of a domain; (2) making a composition on the computer allows the learner to take their abstract thinking (e.g., what the child hears “in their head”) and make it concrete; and (3) adds that when the teacher designs activities that couple the activity (e.g., music composition) with talking, it also promotes making the abstract more concrete.

As mentioned earlier, children know more about music than they are given credit for, but are unable to explore that knowledge due to the pedagogical limitations in learning music (e.g., instrument training, music reading) (Bamberger, 1996; 2003). However, research shows that children readily make up their own songs all the time (Campbell, 1998; Hickey, 2012; Upitis, 1990). Unfortunately, productive teaching and learning moments are lost because teachers either are not trained in music composition or are not familiar with the technological advances that may produce productive learning moments (Hickey, 2012). There is a curricular approach that encourages learners to question their assumptions about music and how it functions within particular contexts (Bamberger, 2000). Unfortunately, this curriculum was designed for college-aged students and not elementary-aged children. However, earlier work using Impromptu (c.f., Downton, Peppler, Bamberger, 2011) allowed for a modification to the curriculum to make it more developmentally appropriate.

The unique approach in this study is two-fold. First, students work collaboratively to make a composition. This allows them to build their understanding through the discourse in the classroom. This is not the case in more formal music settings where composers usually work alone until the entire song is finished. Second, the focus is placed on eliciting different types of intuitive responses within a constructionist environment. As noted earlier, Bamberger's (2000) questions (e.g., I wonder *why* that happened) were meant as guides for the learner. Even in studies outside of music where prompting learners with simple questions impacted the learners' knowledge (c.f., Chi, et al., 1989; King, 1994), it is still not known as to which questions may be more beneficial for the sophisticated responses that are being sought.

Methodology

Overview

The entire fourth-grade population (N=36) from a mid-sized, midwestern city elementary school was engaged collaboratively in a curriculum that involved composing music on a computer using the tool Impromptu (Bamberger, 2000). The two questions being investigated in this chapter are: (1) what role does the practitioner have in scaffolding students' intuitive explanations? and (2) what types of questions elicit engagement within the structural musical ladder? These questions seek to address the gap that while prompting students to explain their thinking is productive, there needs to be more known about the specific types of questions that elicit quality responses from students. It also attempts to understand better the role of a teacher during a constructionist activity and how they can enhance the knowledge construction and reformulation process.

Drawing on constructionism (Papert, 1980; 1993) as well as sociocultural theories

(Vygotsky, 1978) of learning and development, this study utilized qualitative approaches to data collection and analysis (Creswell, 2009; Creswell & Clark, 2011). While the data presented in this chapter is fundamentally qualitative (e.g., audio/video), analysis techniques include quantizing (e.g., counting the number of "why" questions) the qualitative data to answer the questions in the chapter (Chi, 1997; Creswell, 2009).

Data sources include audio and video of the uniquely designed curriculum in which students worked as a class to compose tunes. Analyses involve quantitative measures, including quantized comparisons of the types of questions asked and the type(s) of responses given during whole-class activities (Field, 2009). Further qualitative analysis employed emerging, as well as established, codes based on pilot work (c.f., Downton, Peppler, & Bamberger 2011).

Setting and Participants

For this study, the focus was on activities that occurred within two combined, fourth-grade classrooms in a mid-sized, midwestern city. The school where the intervention took place enrolls over 253 students distributed between kindergarten through eighth grade. The ethnic and socioeconomic makeup of the school population is approximately 92% Caucasian/European-American/White with the remaining 8% distributed amongst African-American, Asian, Hispanic, and multi-racial with nearly 12% on free or reduced lunch.

Participants in this study included the entire fourth-grade population: a total of two classrooms (N = 36) with an average age of 9.5 years. Institutional Review Board approval was granted (study # 1112007636) prior to collecting any data. Prior to the study, the researcher explained the study to the students (e.g., length of study and type of activities), their option to participate or not participate in the study, their ability to stop participating at any time without consequence, and instructions for completing the assent forms. They were also given forms to take home to parents/guardians to read and sign. Students were given two weeks to return the forms. A total of 100% of the participants returned both assent and consent forms and all participants completed the study. Participants were not compensated in any way for taking part in the study.

A convenience sampling method of selecting participants was used. A convenience sampling method means the groups (i.e., the fourth-grade classes) have already been formed making this methodology most appropriate for this study (Creswell, 2009). Also, the age range (9 to 10 years) is ideal for learners to explore their musical understanding (Hargreaves, 1986: Upitis, 1990) through creative expressions such as composition (Kaschub & Smith, 2009). They are old enough to begin to express their musical likes and dislikes (Hargreaves, 1986) but young enough to not have extended training or formalized education specific to music. Pertaining to the participants in the study (N = 36), there were 50% females (N = 18) and 50% males (N = 18).

The study was conducted over a span of eight weeks, including two weeks of pre-intervention observations, one week of pre-intervention music composition, and five weeks of the intervention itself, totaling approximately 20 hours of instruction specific to music composition using Impromptu.

The intervention occurred during the fourth-grade classes' Science, Technology, Engineering, and Mathematics (STEM) instructional time. Every day, for one hour, both classes went to a room in which the normal curriculum includes using iPads and laptops to make, for example, short instructional movies and audio programs based on different topics. Both general education teachers and the STEM teacher agreed to replace the normal curriculum in favor of the Impromptu activities. The classroom where the STEM class is held is a large room (approximately 25' X 20') where the tables are in a reverse "U" shape. Students were assigned a specific numbered laptop (Macbook) computer to use throughout the entire study. Each computer was equipped with the software Impromptu (freely available at www.tuneblocks.com) and headphones for each student.

The Role of the Practitioner Researcher

The STEM teacher and, at times, both fourth-grade teachers staffed the classroom during the intervention. While each of these teachers showed a great deal of interest in the project, they felt their lack of musical knowledge and technological capabilities would be detrimental. It was decided that I would take a practitioner-researcher role in the study and facilitate the activities during the intervention. I have over five years of experience engaging children in music related activities in both in-school and after-school environments, over 20 years of experience as a musician, and over 10 years of professional experience in electronic music production and composition. Taking this practitioner-researcher approach allowed me to reflect on my abilities as a practitioner and thus analyze and make claims about effective practice that may help teachers in the future (Schön, 1983).

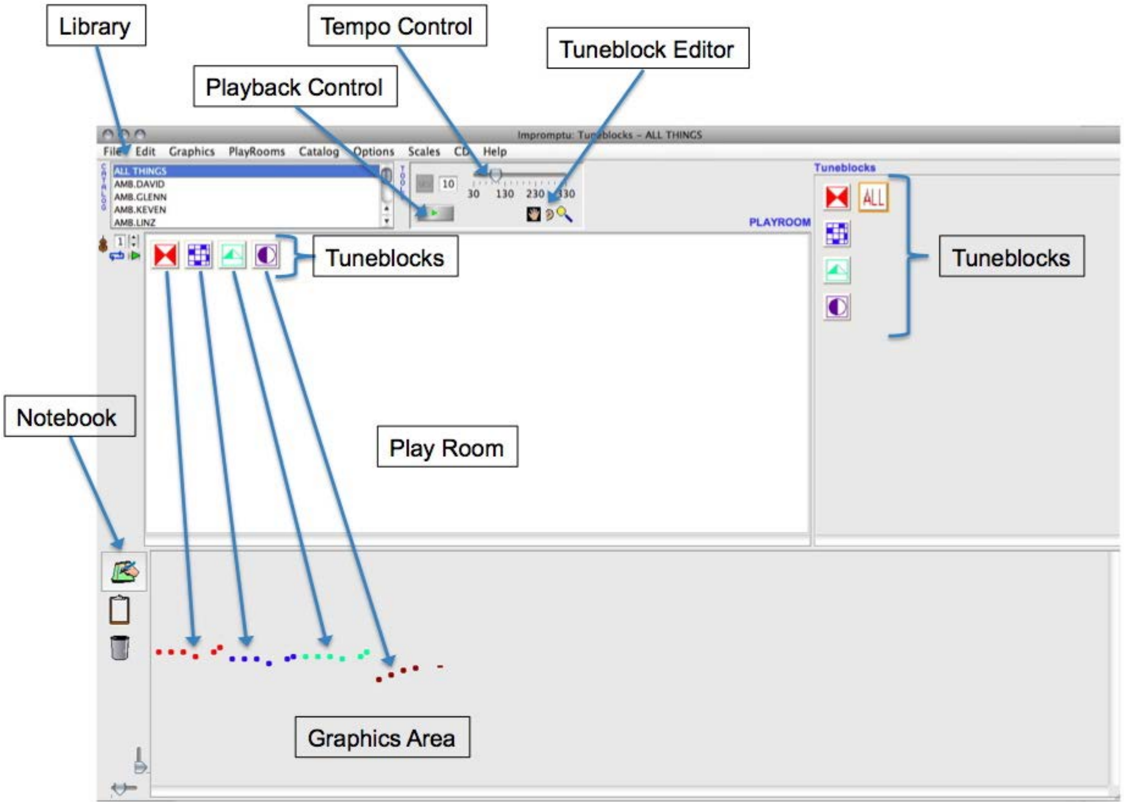
The guiding pedagogical approach taken during the intervention engaged students in discourse that produced an exploration around key issues in the domain (e.g., music) while they were engaged in making an artifact (e.g., music composition) (Sandoval, Daniszewski, Spillan, & Reiser, 1999). This approach was modeled by previous research (c.f., Downton, Peppler, Bamberger, 2011) in which I, as the researcher, facilitated a short, whole class activity centered on composing a tune using the Impromptu software. It was the analysis of that activity that influenced the research being addressed in this chapter and dissertation as a whole.

The overall goal was to create an environment where students could feel free to express themselves and explore the domain without any consequence related to the correctness of their engagement. A conscious effort was made to include as many suggestions from students as possible.

Impromptu as a Tool for Music Composition and Intuition Development

Impromptu (Bamberger, 2000) was designed to allow learners to address, act, and reflect on their intuitions by presenting musical phenomena situated within meaningful (virtual) blocks of music, called tuneblocks. As Bamberger (1996) posits “Impromptu makes it possible for students to begin their music study at the mid-level of structure” (p. 44). The mid-level structure (e.g., tuneblock) she is describing refers to the meaningful structures that people already have about music, including phrases (larger sections or whole songs), figures (smaller phrases), and the functions of stability and instability in music. Starting at this ‘mid-level’ allows learners to move freely to larger structures (e.g., whole songs) and to more detailed structures (e.g., notes and durations) (Bamberger, 1996). When learners are able to work with these tuneblocks, their assumptions about music and musical structures are challenged. When this is coupled with their talk, their intuitions become explicit. This also allows the practitioner to address their inquiry in ways that allows learners to engage in reasoning and exploration of the domain (Sandoval, et al., 1999).

Figure 2. Screenshot of Impromptu Interface



To navigate Impromptu (see Figure 2), users pick a tune from the menu; the tune is then represented and broken up into different virtual blocks in the tuneblock area with the playroom area being empty. Users can then drag the blocks into the playroom to put the blocks back in order to recreate the song, make a new song by rearranging the blocks, insert rhythmic blocks, or edit the blocks themselves in order to make an entirely new composition. This allows learners to question their intuitions under the premise of “what happens if…?” This is important because it allows the learner to reformulate their knowledge of the domain and thus connect to powerful ideas about music (Papert, 1980). Impromptu can also be viewed as a meditational tool or a go-between that influences the learners’ ultimate goal of, for example, creating a composition. It is, in essence, both an extension of the learner and a tool for solving problems (Roth, 2007) that arises during composition.

Overview of the Curriculum

Prior to the implementation of the Impromptu activities, I asked the music teacher at the school as to the types of activities students would engage in during music class. She indicated that most of the activities revolved around singing (e.g., preparing for holiday programs) and playing music related games that involved some rhythm and music reading (e.g., notes on a staff). Additionally, as a reward to students, she would allow them to play on some of the instruments (e.g., drum set, piano, maracas, and xylophone) towards the end of class. However, the musical games and involvement with the instruments were not grounded in any music creation activity. The curriculum used in this study emphasizes music creation.

The curriculum consisted of four main activities adapted from Bamberger (2000): Reconstruction, Construction, Building Meter (e.g., rhythm), and the Final Project activity. Briefly, during the Reconstruction activity, students are presented with a tune that contains a number of tuneblocks. They are asked to put the tuneblocks in order to recreate the song. The Construction activity gives learners the opportunity to create their own song using the tuneblocks given to them. The Building Meter activity allows learners to construct a beat to a popular melody using tuneblocks that contain rhythmic patterns. The Final Project activity presents learners with the opportunity to create their own tune, from scratch, utilizing all the components discussed during the intervention. Each of these activities alternated between collaborative, whole-class work and individual work. As Bamberger (1996; 2006; 2013) has alluded to several times, what novice music learners pay attention to is markedly different than what normally is taught. The design of both Impromptu and the curriculum presented here allows learners to explore their intuitions about music. The practitioner can then adjust the flow of discourse in the class through the use of questions (e.g., how, what and why questions) (see Table 1 for a breakdown and further description of each of the four areas of the curriculum).

Table 1

Overview of Curriculum With Number of Days and Approximate Hours, Type and Description of Activity, and The Tunes Used For The Activity

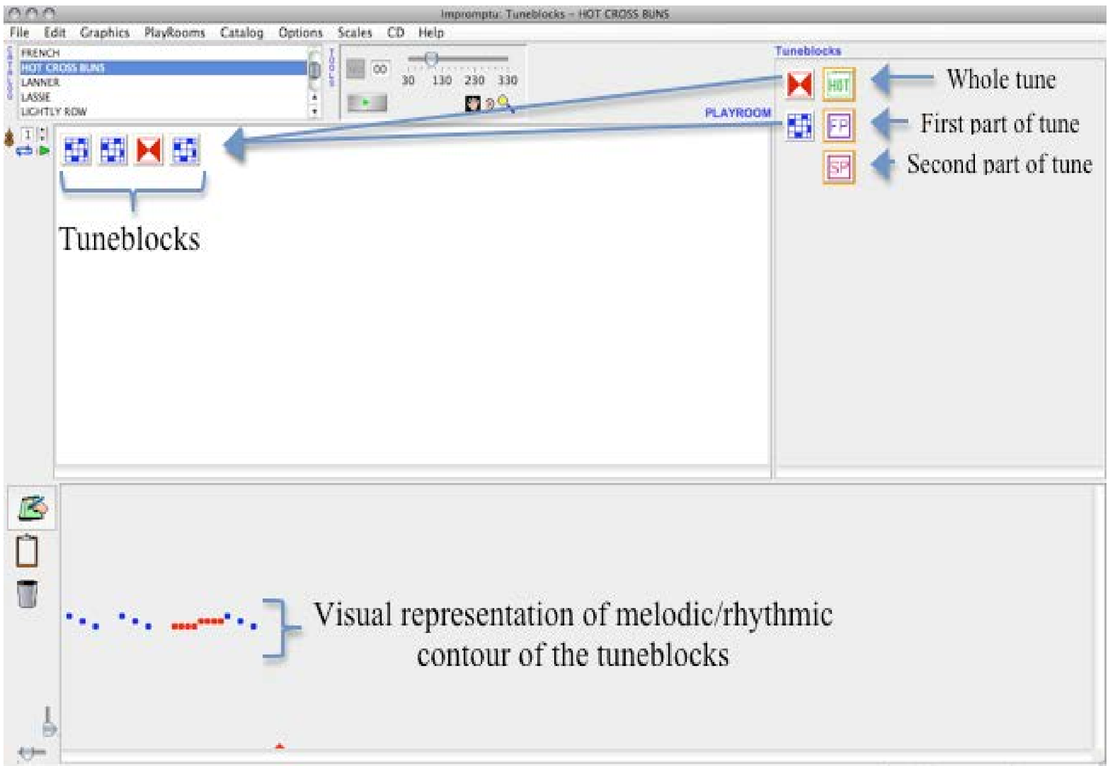
Days (Total time[3])	**Activity**	**Description**	**Impromptu Tunes Used (Whole-class composition / Individual composition)**
1 - 3 (~3 hours)	Reconstruction	Take familiar song and put the tuneblocks in order to recreate the tune.	Hot Cross Buns / Lassie
4 - 8 (~5 hours)	Construction	Utilize familiar sounding tuneblocks (e.g., tonal) to create unique tune. Users listen to each block and place the blocks in any order they see fit.	English / Vienna
9 - 13 (~5 hours)	Building Meter	Users will create a rhythmic accompaniment to an already established melody.	Hot Cross Buns / Lanner
14 - 21 (~8 hours)	Final[4]	Users will listen to tuneblocks that are atonal—they have no tonal center or established rhythm (e.g., duple/triple meter). They will then be able to edit these tuneblocks or create new tuneblocks using the tuneblock editor.	Ambrosia / Portals

Each activity in the curriculum builds off of one another. To illustrate this, in the Reconstruction activity, users piece a tune together using the available tuneblocks. Sometimes the number of tuneblocks given does not match the intuitions of how the song is structured. For example, the song Hot Cross Buns only has two tuneblocks (see Figure 3) and when users hear

[3] Class times varied and were dependent on several variables including school assemblies, hold-over from other classes, and discipline issues. The practitioner made every effort to make sure students were given the full amount of time each class period.
[4] Prior to the final project, two class times were used to show students how to make their own tuneblocks.

the two tuneblocks, they inevitably think that more blocks are needed in order to put the song back together.

Figure 3. Impromptu Screenshot of Reconstructing the Tune “Hot Cross Buns”



It is not until the user can begin to manipulate the environment (e.g., dragging tuneblocks into the playroom) and thus challenge their intuitions that they realize the importance of repetition in music. They also can see and hear the structure of a song (e.g., beginning, middle, and end) via the tuneblocks (e.g., melodic phrases). Moving to the second activity, users can use the knowledge they have constructed in the first activity to create their new song.

Each activity consisted of a whole-class component and an individual component. However, since the focus of this chapter is on how I, the practitioner, engaged students’ intuitions, only data from the whole-class activities are examined. During whole-class activities, students would work together while I lead the activity. Any decisions the student made about the composition, I would ask follow-up questions (e.g., “why do you want the blue tuneblock to start the song?”).

Typical Classroom Interactions

For each of the whole-class activities, the structure was consistent. Upon the students’ arrival in the class, I explained the activity (e.g., constructing a tune). I would be at the front of the room with the Impromptu screen projected onto the classroom’s Smartboard for the class to see. I would then play the available tuneblocks to the students and ask questions like “what does that sound like?” or “what do you think of that one”.

Table 2 is a short, 30-second, typical conversation held at the beginning of each activity. This particular excerpt was drawn from the “Construction Activity” (day 4) in which students were to construct a tune using the given tuneblocks in Impromptu. The tuneblocks used in this activity were tonal (e.g., tonal center and common rhythm) and could be placed in any order to construct a tune. It is presented here to illustrate the ways in which the practitioner would scaffold student explanations and the ways in which students engaged in the discourse.

Table 2

Typical Interaction Between Practitioner and Student(s) During the Construction Activity (Day 4) with Transcription and Interpretation

Line	Speaker	Transcription	Interpretation
1	Practitioner	Lets listen to the blocks…listen carefully and then I'm going to ask you questions after each one (*plays tuneblock).*	The practitioner is providing a context for the students to begin a conversation about what it is they are hearing
2	Practitioner	What did people think of that one? Let me play it again…(*plays tuneblock*).	
3	Practitioner	(*Gabe raises hand)* What do you think Gabe?	The practitioner calls on Gabe to provide his thoughts on what was heard
4	Gabe	It's longer than all the other blocks we have heard so far…	This is a general response (e.g., GIR). That is, Gabe only says that it is longer and does not justify, infer, or explain any further.
5	Practitioner	Well, we've only heard one block…	
6	Gabe	No, like in the other thing…	Gabe is referring to activity the day before. Those blocks were considerably shorter.
7	Practitioner	Oh, ok, well let's just talk about this one…so you are saying that this one is longer?	
8	Sam	No, that wasn't longer…	Sam suggests that Gabe's interpretation is not correct. However, he too does not try to explain further.
9	Practitioner	Why do you say that it's longer?	The practitioner follows up to try and elicit a more sophisticated response from the students.

The interaction started out with the practitioner playing the individual tuneblocks that the students were going to be working with (lines 1 - 3). This was done to not only provide a context for the students, but also engage them in conversations about what it is they hear (line 2). Again, the focus of the analysis is how the practitioner engages the students. As can be seen, Sam interjects (line 8) that Gabe's earlier claim is not correct. However, Sam does not immediately offer any reason for his disagreement with Gabe. The practitioner then moves the discourse along by asking for clarification (line 9). The way the practitioner used this and other types of questions was typical throughout the course of the intervention.

To show consistency over the course of the intervention, a brief excerpt (see Table 3) from the Final Project (day 15) is presented. To give a context for this excerpt, the class had started out the project (day 14) by having a conversation about what type of song to compose. The students decided on something *techno* and *adventuresome.* The blocks they were going to use were atonal (no tonal or rhythmic structure) which provided them an opportunity to edit and or make new blocks to achieve their end goal. It is important to note how I engaged the students in the conversation and how the discourse progresses. Composing a tune, especially one done collaboratively, is not an easy task. There are many differing opinions and approaches that could be taken and I made sure to not discount any suggestions or opinions, but also understood the importance of moving the creative process forward.

Table 3

Typical Interaction Between Practitioner and Student(s) During Final Activity (Day 15) with Transcription and Interpretation

Line	Speaker	Transcription	Interpretation
1	Practitioner	Lets listen to these blocks (*plays tuneblocks*)	Setting a context to begin the conversation.
2	Class	Ewww! No!	The blocks were atonal (e.g., no tonal center and unpleasant to the ear). Class as a whole had a visceral reaction.
3	Practitioner	I don't like any of those, I don't know about you…	Goal was to implicitly suggest that the class needs to construct new blocks (or edit the existing blocks) to reach their goal.
4	Matthew	It would be good for scary stuff…	This is a general response. Since the blocks were atonal, they were dissonant and hence the "scary" metaphor. However, no further explanation as to what makes the blocks sound scary.
5	Practitioner	A scary one, but we are doing techno-adventuresome, right? So how are we to start this one out?	Moving the discourse along.
6	Mya	Well, if we wanted something, uh, like Star Wars, the blocks would be to high…or uh, to low.	Mya provides a sophisticated response in that the notes in the tuneblocks we have are either to high and to low. This suggests that melodic contour is an important concept in Mya's explanation.
7	Practitioner	So, yeah, if we wanted to do something like Star Wars, it wouldn't work cause they are either all to high or all to low.	Restating Mya's explanation to elicit more responses from other students.
8	Class	(*chatter about the blocks—agreement and disagreement)*	
9	Practitioner	From my experience, songs can start with a simple drumbeat, they can start with a note, they can start with a chord, they can start with somebody singing something and	Suggesting to the students how a song can be can be constructed and that we do not need to rely only on what is given (e.g., atonal tuneblocks).

		the next thing you know, you got a song. But it takes time. So we can start this out however we want…we are all the band. So how do we want to start this out?	
10	Owen	We want to start it out with some low notes…so 'duh-duh'. To go with this (*point to the screen*). It can't be just anything because all those are pretty sad and we don't need sad, we need adventuresome.	Owen has a plan of action. While he doesn't suggest how we do the 'duh-duh' yet, he justifies his response by saying the given tuneblocks are to sad.

The visceral reaction by the students (line 2) to the atonal tuneblocks allows the practitioner to use that as a starting point for the ensuing conversation (line 3). What follows is a focus, by the students, on what is given in the tuneblocks and not what could be if the blocks were changed (see lines 4 and 6). I agreed with Matthew (line 5) and added an inquiry about how the song might start out given the *techno-adventuresome* theme proposed by the students. I then used my own experience as a musician and writing songs to help the students understand the processes involved in writing a song (line 9). This seems to influence Owen as he suggests a beginning for the tune (line 10). The above excerpt highlights how I engaged the students with questions that guide their thinking and subsequent planning process.

The data analyzed in this chapter is drawn specifically from the whole-class activities. This is because the central focus of the chapter is the interaction(s) between myself, the practitioner, and students and how I utilized simple inquiry to elicit sophisticated intuitive responses.

Data Source and Analytical Techniques

The main source of data being analyzed for this chapter is the audio and video data taken during the whole-class activities. Each classroom activity was videotaped using two digital video cameras with wide-angle lenses, directional microphones, and high-quality wireless microphones strategically placed throughout the classroom. Specifically, the wide-angle lens cameras were positioned at the front of the room in opposite corners. This allowed for a full view of the entire class and allowed for easy identification of who was talking during the whole-class activities. While each camera had its own built-in microphone, it was not sufficient to capture the students' talk during the intervention. Therefore, each camera was equipped with a signal mixer that allowed two separate audio signals (e.g., left and right) from different microphones to be used instead of the built-in camera microphone. To utilize this mixer, two separate microphones were used; a directional microphone and a wireless lavaliere (i.e., lapel) microphone. The directional microphones were mounted on top of the cameras and its signal was routed to the left audio channel. These microphones are designed to capture sound specifically from the direction in which the microphone is pointing. While this provides good quality, issues such as ambient room noise (e.g., air conditioners) can interfere with the overall audio. To address this issue, two wireless, highly sensitive, lavaliere microphones were used and their signals were routed to the right side. The first was placed at the front and center of the class. This allowed students who were not in the direct path of the directional microphones to be clearly heard. The second wireless microphone was placed in the center rear of the room. Again, this allowed students in the back of the room to be easily heard on the video. As mentioned, audio from each microphone was split into separate left and right signal flows. This allowed for easier transcription of the audio. Fortunately, the video and audio captured on one camera was sufficient to analyze however, if there were any questions as to who was talking or what was being said, the second video was used to clarify any issues.

A qualitative and quantitative approach to data collection and analysis requires differing and appropriate analysis methods (Creswell, 2009). This allows for a qualitative approach (e.g., analyzing student talk and practitioner inquiry) coupled with quantitative support of the qualitative findings (e.g., number of questions used at a particular time) (Chi, 1997).

To investigate the role the practitioner has in scaffolding students' intuitive responses during whole-class activities (RQ 1), it was determined that the specific units of analysis for this question were turns at talk (Goodwin, 1979) by (1) the practitioner (e.g., asking questions) and (2) the student. Specifically, when I (practitioner) would engage students by asking a question like "how should we start out this song?", my question would be considered a turn and the response the student gave would be a turn. Quantitative counts of the total number of utterances (e.g., practitioner and student) were generated. This allows for an analysis of how involved the practitioner was during the intervention. For example, it is not enough to only provide a quantitative count of the number of questions asked. However, if that number is coupled with the total number of excerpts, it provides a richer context with which to make claims about the number observed.

To investigate the specific types of questions that influence intuitive responses (RQ 2), videos were further reviewed and specifically tagged for the specific types of question asked (e.g., how, what, and/or why questions). As an example, if I asked "how should we start this song?" is considered one utterance and further coded as a *how question.* Only utterances that specifically asked "who", "what", and "why" questions were used in the analysis. The reason for this is two-fold. First, the research question being addressed calls for what specific type of question elicits intuitive responses. Secondly, I made a conscious effort to only ask these types of questions throughout the curriculum. If there were questions that were not "how", "what", or "why" questions, they were not included in the analysis. Further, student responses were coded for their placement on the SML. This allows the types of questions to be mapped on to the responses.

To determine the reliability of the coded data, the coding manual and segments of data (30%) were given to two other researcher/practitioners unfamiliar with the research. This technique allowed the researcher to check whether the codes and their applications are reliable to the data (Creswell, 2009). An analysis of inter-rater reliability using Cronbach's Alpha found that there was agreement across 93% of the data indicating the coding guide to be reliable.

With regards to validity, both internal and external, several strategies were utilized to guard against any threats. The first is utilizing a peer to review the study and ask pertinent questions that may be relevant to the research. Second is the amount of time spent in the field. While there were 20 hours dedicated to the curriculum, there were also two weeks spent observing the classrooms prior to any intervention. Also, this particular school dedicates less than one hour per week to music education, totaling approximately 36 to 40 hours for the entire school year. The curriculum for this project was given more than half that time. Having this much time in the field contributes to the validity of the findings. Finally, using descriptive techniques gives the reader a sense of the interactions that happened during the intervention. All of these can contribute to the validity of the findings and combat any potential threats to validity (Creswell, 2009).

The following section presents findings from the study by first investigating the role of the practitioner in scaffolding students' intuitions and then moving on to the specific type of questions that influences the expression of these intuitions.

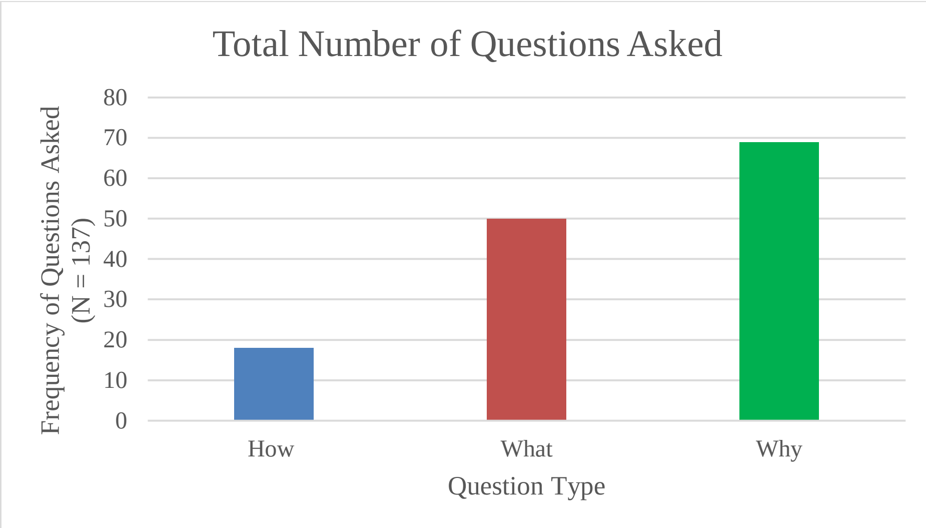
Findings

RQ 1 – What role does the practitioner have in scaffolding students' intuitive explanations?

To investigate the role the practitioner played in scaffolding the students' explanations during the whole-class activities, the number and type of questions asked over the entire intervention were analyzed. Concentrating on specific types of questions (how, what, and why) is beneficial for two reasons. The first is that it narrows down the specificity to what it means for the practitioner to scaffold students' intuitive explanations. While previous research on prompting student explanations shows positive learning outcomes (c.f., Chi et al., 1989; Chi, et al., 1994), it is unclear as to what, specifically, elicits good explanations. Narrowing down not only the types of questions but also the types of responses allows further claims to be made about the role of the practitioner.

Videos of the whole-class activities were coded for instances when the practitioner asked how, what, and why questions. Counts were generated and it was observed that over the entire span of whole-class activities (approximately 10 hours) the practitioner asked a combined total of 137 questions. Figure 4 provides a breakdown of the number and type of questions asked during each activity.

Figure 4. Type and Frequency of Questions Asked During Whole-class Activities



Over the course of all the whole-class activities, there were a total of 335 utterances by students (n = 198) and the practitioner (n = 137). As a reminder, an utterance is a segment of the video when either the practitioner asks a question or when a student is talking about the activity/problem at hand. This means that 40.89% of the utterances were from the practitioner.

While it may seem like I (practitioner) am dominating the classroom discussion, I argue this is not the case. This is because of the types of questions I asked the students. These questions are very short and designed to engage students in exploring and expressing their intuitive assumptions about music. To give some perspective, my utterances were timed during the first twenty minutes of two videos; one taken at the beginning of the study (e.g., Construction Activity) and the other at the end (e.g., The Final Composition). The first twenty minutes was used for consistency. That is, the beginning of the activity was typical in that the students and practitioner would talk about the tuneblocks they were hearing. It was observed that over the twenty minute period, the practitioner only spoke an average of just over four minutes. This amounts to approximately 20% of the conversation is by the practitioner.

As Lemke (1990) points out in his objection to the common classroom teacher/student interactions, students should be given the opportunity to talk and express themselves in non-judgmental ways (e.g., fear of getting wrong answer) and in several contexts (e.g., individually, small group, and whole class), and teachers should do what they can to facilitate these types of interactions. Because the focus was less on correct answers and more on engaging students' intuitions, asking these short and open-ended type questions allowed students to talk like a composer would talk. This allows them to make connections, understand relationships, and critically reflect on their and their classmates' knowledge (Lemke, 1990). Finally, the focus of the data (both quantitative and qualitative) is less about the general idea of prompting students to explain their thinking (c.f., Chi et al., 1989; Chi et al., 1994) than it is to a more specific alignment with what types of prompting (e.g., the types of questions) elicit different types of responses.

The question now shifts to the specific types of questions that encourage engagement within the SML. The next section will specifically look at the types of questions asked and their impact on the types of responses given by students.

RQ2 – What types of questions elicit engagement within the structural musical ladder?

A conscious effort was made throughout the whole-class activities to ask how, what, and why questions. The goal of these types of questions was to get students to think and talk like a music composer would: to think about the form and functions of music within a particular context as they are making a song. The goal of this research question is to determine to what extent did the specific type of questions (e.g., how, what, and why) promote movement within the SML.

To show the impact the types of questions have on the students' engagement within the SML, a co-occurrence chart showing what specific questions mapped onto the type of responses (see Table 4).

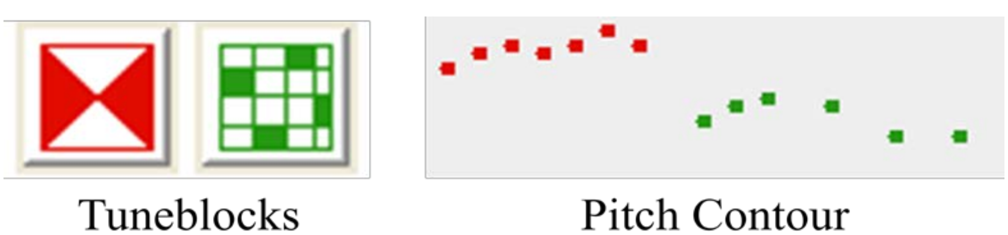
Table 4

Co-occurrence Chart Mapping Questions Asked and Responses Related to the SML

	Low-Level Structures	Mid-Level Structures	**High-Level Structures**
How	**0**	15	**2**
What	**14**	52	**11**
Why	**15**	87	**17**

Remember, mid-level structures are what the student already knows and knows how to do. Low- and high-level structures are what emerge when learners are able to interact with music beginning at the mid-level structure and, therefore, more significant. It was observed that low- and high-level structures occurred most through "what" and "why" questions from the practitioner. To better illustrate this, an excerpt between the practitioner and a student (Gabe) is presented. This particular example was drawn from the "Construction" activity (day 4). At this point in the activity, some students have made suggestions that have been tried out. After one particular grouping of blocks is played (see Figure 5), a mixed reaction from the class is observed.

Figure 5. Tuneblocks Being Discussed and the Visual (Melodic) Representation



Note in Table 5 the response from Gabe after he is asked a "why" question.

Table 5

Interaction Between Practitioner and Student Utilizing a "Why" Question and the SML Response that Follows

Line	Speaker	Transcription	Type of Question	Interpretation (SML)
1	Practitioner	Who's like "ehhh" we need to try something else?	--	At this point, we have tried a few suggestions and none of them really sounded correct. The practitioner is moving the activity and discourse along.
2	Gabe	(raises hand)	--	
3	Practitioner	Gabe, **why** do we need to try something else?	*Why*	This is meant to elicit a response as to why the current configuration of the tuneblocks is not sounding good.
4	Gabe	Because, it doesn't sound right to go from a really high thing…just to like, start out with a real, real low thing. Cause, see (*pointing to the bottom of the Impromptu display on the smart board),* where it has the dots, it has a high and then too much under it low. Then it goes high, then really low.	--	Gabe is noticing the large jump in notes between the red block and the green block. Essentially he is commenting on the melodic contour of the tune and how the large jump in notes does not fit with how he thinks the beginning should be. (This is a comment on all three levels of the SML. The mid-level being the melodic contour of the tuneblock. The low-level being the pitches involved "…really high thing…to real, real, low thing". The high-level structure is how this impacts the overall tuneblock "…it doesn't sound right…")

When Gabe is asked a "why" question (line 3) he explains that the gap in pitches between the two blocks does not sound right, indicating there is not a smooth transition between the blocks and thus revealing the importance of how melodic contour functions in the larger aspects of music making. These types of explanations following a "why" question were typical throughout the intervention. Similarly, "what" questions had a similar impact. The following excerpt was taken from the same day as the above excerpt. Owen was explaining that what has been constructed does not sound right (see Table 6).

Table 6

Interaction Between Practitioner and Student Utilizing a "What" Question and the SML Response that Follows

Line	Speaker	Transcription	Type of Question	Interpretation (SML)
1	Practitioner	It doesn't sound right…but what about it doesn't sound right?	What	--
2	Owen	It jus…it's just so high-pitched…like the songs you hear on the radio won't be so high pitched when you get into it.	--	Owen is commenting first on the pitch of the notes in the block (low-level) but then moves to high-level structures when he equates what he knows about songs on the radio.
3	Practitioner	Aiden		--
4	Aiden	The gaps in the middle don't sound right…	--	Aiden is bothered by the gaps between the tuneblokcs that have been created. He obviously has an expectation based on what he knows about music (his intuitions – e.g., mid-level structure)
5	Practitioner	…you said the gaps in the middle don't sound right?		I interrupt Aiden because the room was noisy and I wanted to make sure that I heard him correctly.
6	Aiden	The gaps that make, uh, the second block sound like it's starting over again.		Aiden has pointed out an important point here in that certain blocks have certain functions (beginning, middle, or end) and there seems to be nothing that brings the blocks together (e.g., a middle).

Again, when Owen is asked a "what" question (Line 1), he comments (Line 2) on the pitch of the notes (low-level structure) and then evaluates what he hears to what he has heard on the radio (high-level structure). Aiden adds (Line 6) an insightful hearing of the tune in that what has been constructed so far does not seem to have a middle section. This reflects the function of the instability of the grouping of tune blocks (mid-level structure) and how that impacts the overall tune (high-level structure).

By contrast, the "how" questions rarely occurred with responses that reflected low- or high-level structures. A reason for this is because "how" questions are process-based questions. For example, during the Final Project activity (day 15), the students were having a difficult time figuring out the beginning of their song. They had spent considerable time discussing what they wanted the song to sound like, but did not know how to accomplish the goal. They had made and labeled some of their own tuneblocks and rhythmic tuneblocks and, after several suggestions from the class on which ones to use, Eva claims enthusiastically, "I want to start it with the beat". The practitioner recognizes Eva's suggestion but poses a new problem of connecting two tuneblocks together by asking "...can somebody tell me, *how* then can we make this come in later". Eva quickly responds by saying "you put it in front of the beat". However, she does not offer any other justification for her answer. This is because the asking of "how" engages the student on how to do something and thus giving a reason for their thinking is not implied. This does not mean that "how" questions should not be used. To the contrary, it is important for students to talk about the domain they are working in no matter the quantity (e.g., length of the talk) or the quality (e.g., correctness) (Lemke, 1990; Wells, 1999). The "how" questions still elicit talking out of the students. However, it may be more appropriate to follow up a "how" question with a "what" or "why" question.

Limitations of the Current Study

The non-randomization of participants was a limitation to this study. Not being able to fully randomize prohibits the claims being made to be generalizable to larger populations.

However, because the focus was on younger learners (fourth grade) and 100% participation was observed throughout the study with no attrition, it helps in strengthening the claims made in this chapter. Next, the researcher as practitioner was a limitation. This may introduce some bias into the how the curriculum was carried out. However, using other researchers to code the data and provide feedback on the overall quality of the data presentation helps address this limitation.

Discussion

The findings in this chapter promote the idea that the teacher can be actively involved in eliciting intuitions by asking simple open-ended questions to their students. While there have been general broad claims made about the role of the teacher (e.g., the need to prompt learners), little was known about what specifically the teacher does and how the teacher can elicit more sophisticated responses from their students. From a research perspective, pedagogical practice is just as important as what the student learns. Being able to understand better how teachers and practitioners can engage their students can help inform curricular and pedagogical designs in the future. Also, this research can help inform teachers in the practice of asking “what”, “how”, and “why” questions as a way to engage their students to talk. It can also be a way for teachers to formatively assess what their students know (or do not know) by specifically asking “why” questions. With a significant emphasis being placed on the processes involved in solving problems (e.g., Common Core), policy makers can use the research in study to incorporate simple questions into teacher practice that can then be used as a standard for teachers.

As researchers investigating the questions teachers ask students, especially in general education topics (e.g., math, science, and language), the role the teacher plays in initiating a productive discourse is essential to knowledge construction (King, 1994; Schön, 1983; van Zee and Minstrell, 1997). The purpose of engaging students by asking simple “how”, “what”, and "why" questions is not to determine how right or wrong a statement is, but to allow students to reflect on their thinking and make informed choices based on what they know.

The role a teacher has on a student's knowledge construction is vital. As demonstrated by the findings in this chapter, the practitioner was actively involved in scaffolding student explanations by asking questions to elicit deep, reflective responses. The practitioner's ability to ask pointed and open-ended questions shifted the responsibility on the student in articulating their thoughts rather than on the teacher searching for a right answer. This, especially in a constructionist environment, is essential for learning; it helps the student become a better learner by allowing them to explore how they think (Papert, 1980).

It was also observed that asking "why" and "what" questions had the most positive impact on students' engagement with the SML. These questions afford students the opportunity to reflect on their practice and thus verbalize the powerful intuitions they have about a phenomenon. When teachers ask a "why" and "what" question, especially when it is used as a follow-up question, it allows them to gain a better understanding of what the student is thinking.

The research presented in this chapter contributes in two ways. First, the activities were grounded in a constructionist environment. This allows learners to construct an artifact that can be shared with others in the community (e.g., fourth-grade classroom) (Kafai, 2006; Papert, 1980; 1991). When learners engage in making something (e.g., music composition) coupled with the opportunity to verbally express their thinking, their knowledge of and their place within the domain is reformulated (Bers, 2008; Kafai, 2006; Peppler & Kafai, 2007; Vygotsky, 1974). The role of the teacher in a constructionist environment is largely overlooked. However, the findings in this chapter suggests that teachers in a constructionist environment should be active in engaging students to verbalize their thinking by asking short, open-ended questions to their students.

Secondly, the fact that this particular project centered on music will help inform music educators to (1) promote more music creation that emphasizes students to talk while they create; (2) encourage teachers to ask simple, open-ended questions to students; and (3) understand that students have intuitions about music and that these intuitions can be useful for learning more formal musical concepts (e.g., notation). Teachers in the arts, and especially music, are pressured to produce some tangible outcome, either through band, choir, or orchestra performances or through testing. This pressure is derived from budgetary constraints and the misconception that these subjects are not as valued as the core subjects (e.g., math and science), and therefore teachers feel the need to justify their practices. This is detrimental because when teachers only focus on these performance outcomes, it alienates students that may have an interest in music but not possess the ability (e.g., playing an instrument) or aptitude (e.g., reading music notation) to meet the teachers' predetermined needs (Bamberger, 1996; Wiggins, 2009).

CHAPTER THREE

The Use of Intuitive Explanations to Guide Music Making, Thinking, and Learning

Abstract

One important factor, among many, in learning is that reflection and other metacognitive processes are vital for learners to use in order to make sense of the domain in which they are engaged (Bransford, Brown, & Cocking; 2000). These reflections are most beneficial when a learner is able to articulate their understanding (Chi, et al., 1989; Sawyer, 2006) in ways that emphasize their intuitions (Bamberger, 2013; diSessa, 1993). However, we know little about how to best encourage learners to use and trust their intuitions during reflection that promote high quality learning and domain engagement. Consequently, this chapter examines two important dimensions of reflection in the learning and intuition development process. First, this chapter compares a process of reflection in which learners are encouraged to reflect-in-action and reflect-on-action and the immediate impact on the quality of student learning and engagement in the domain. Secondly, this chapter investigates the impact that the type of design activities (open-ended and creative vs. goal-oriented and constrained) and the type of reflection practice have on learning and engagement. Furthermore, when well-constructed, these reflections evolve to a more sophisticated understanding of the domain over time. To investigate these areas, this study is situated in the field of music education and uses both collaborative and individual music making as a backdrop for these investigations. Four computer-aided music composition activities—two open-ended and two goal-oriented—rooted in constructionist and sociocultural frameworks were implemented in two fourth-grade classrooms (N=36) in which students were given opportunities to reflect-in-action (via classroom talk) and reflect-on-action (via written journals). Specifically, I ask when fourth-grade students engage in both reflection-

in-action and reflection-on-action, which type of reflection seems to promote greater domain engagement? A sub-question is how are the domain specific responses (i.e., advanced musical concepts) distributed during each activity? Finally, I ask what impact does the type of activity have on student's sophisticated discourse in the domain?

Data, including audio/video from classroom activities as well as written journals were analyzed. Patterns in learners' intuitive explanations over the course of the study were analyzed by quantizing qualitative data (i.e., counts of advanced musical responses) along with supportive data from classroom interactions and student journals. Findings suggest that giving learners the opportunity to reflect-in-action during open-ended design activities may be most conducive for high quality learning. That is, open-ended design activities paired with reflection-in-action seem to allow learners a greater degree of agency to see and hear their thinking take shape and thus modify their thinking if need be.

Introduction

Reflecting both in- and on-action is, in essence, a metacognitive process in which professionals / experts can express what they know—via a demonstration, performance, or talking—within a specific domain (Schön, 1983; 1987). I parse out reflection-in and on-action by taking a straightforward approach in that reflection is happening either during (reflection-in-action) or after (reflection-on-action) an activity. While this is a quite literal use of the terminology and ideas presented by Schön (1983; 1987), the reason for this is a practical one. First, and most important, is that the participants in this study are younger (fourth-grade) students who are not experts or professionals in the domain. This is important because reflection-in-action is a major factor in how professionals do what it is they can do (Schön 1983). Essentially, when a professional (e.g., an expert) engages in their domain specialty, the knowledge they use is located within the activity itself and any new knowledge gained is constructed through a reflection-in-action process. More specifically, when the feedback during an activity is, for example, surprising, this promotes a reflection-in-action. This reflection, in turn, allows for explicit knowledge to be used and new knowledge to be constructed. A component of these reflections is the professional's intuitions (Schön, 1983; 1987).

What, then, are these intuitions? Intuitions are knowledge structures that are activated through experiences (c.f., Bamberger, 1996; Bruner, 1977; diSessa, 1993). For example, if you ask a child what will happen if a ball is dropped, they will be able to say, with some level of accuracy, what will happen. While they presumably do not have any formal knowledge of physics, their intuitions help them decipher what will happen. Within the context of music, a child could hear the tune "Mary Had a Little Lamb" without the very last note and be able to pick out that note on a piano if they were asked to do so. This will be expanded on later in the chapter.

Within the context of reflection in- and on-action, a professional has a myriad of experiences within their area of expertise in which their intuitions help direct these reflections while engaged in an activity. Unfortunately a major hurdle to learning, especially with younger learners, is valuing the prior experiences and intuitions of the learner in relation to what is being learned (Bamberger, 1996; 2003; Smith, diSessa, & Roschelle, 1994). These experiences and intuitions help the learner make sense of unfamiliar and new phenomena they encounter (Bruner, 1977; Noddings and Shore, 1984). Intuitions have garnered some attention in the Learning Sciences over the years (c.f., Clement, 1993; diSessa, 1993; Resnick & Wilensky, 1998; Taber & García-Franco, 2010; Zietsman & Clement, 1997) as well as in arts-related domains (c.f., Bamberger, 1995; 2000). The claims about intuitions, regardless of the domain, have alluded to the fact that intuitions are important to understand because they may be most beneficial to learners when they understand to trust their intuitions rather than view them as invalid (Bamberger & diSessa, 2003).

There remains, however, important gaps that need to be better understood regarding if and how younger students (e.g., fourth grade) utilize their intuitions within activities that promote what Schön (1983) refers to as reflection-in-action and reflection-on-action. First, we do not know to what extent certain types of design and pedagogical approaches impact a student's reflection-in and on-action. Second, it is not clear whether intuitions help guide a student to a better understanding of the domain they are engaging (e.g., music). If intuition use can be understood better, then designs for learning can be improved based on these investigations. This study investigates these areas in the domain of music. Music is a fruitful area to investigate because, like many other core domains (e.g., math, science), music values the specialized language, rules, and practices within the domain. However, due to our vast everyday experiences with music—what we intuitively know—these languages, rules, and practices may not be a suitable starting point to engage the domain. The research presented in this chapter seeks to better understand how to shape design and reflection practices to enhance learning and engagement.

The main overarching question for this chapter is: How can we shape design activities, particularly through the design goals and reflection practice, to promote high quality learning and domain engagement? More specifically: (1) When fourth-grade students engage in both reflection-in and on-action, which type of reflection seems to promote greater domain engagement? How are the domain specific responses (i.e., advanced musical concepts) distributed during each activity? and; (2) What impact does the type of activity have on a student's sophisticated discourse in the domain?

Guided by constructionist (Papert, 1980) and frameworks, the current study investigates these questions in the context of two fourth-grade classrooms (N = 36) engaged in a modified college music-learning and composition curriculum using the computer software Impromptu (Bamberger, 2000). Data, including audio/video of whole class activities as well as student journals was collected and analyzed using appropriate qualitative and quantitative methods.

The gaps in the literature remain because further research on intuitions in the Learning Sciences either builds on established claims (c.f., diSessa 1993) within a different science domain (e.g., chemistry) (c.f., Taber & García-Franco, 2010) or uses the term intuition in relation to knowledge that cannot be labeled as a knowledge structure (e.g., something taught) (Clement, 1993; Resnick, 1996; Resnick & Wilensky, 1998; Zietsman & Clement, 1997).

Using a framework that positions a student's reflection at the forefront and how their intuitions can guide these reflections is a fruitful area to investigate further. A unique approach in this chapter is the focus on younger students. This is due to the fact that younger students' experiences with music are extensive without the formal training (e.g., music lessons/formal instruction) (Campbell, 1998) and, while this does not make them experts (or professionals), this research provides a glimpse into how reflection-in and on-action and intuitions can impact student learning.

Background

Constructionist Learning Theory

Constructionism is more than just a theory of learning that posits children learn best when they are actively involved in making things but also involves a pedagogy that allows learners to share their creations with the community (Kafai & Peppler, 2007; Papert, 1980; 1993; Pinkett, 2000). This sharing allows the learner to be more invested in the learning process and enhances both themselves and the community at large (Pinkett, 2000). Even more important, and largely overlooked, are the ways in which making something gives learners the opportunity to use "expressive languages for talking about process and recasting old knowledge in these new languages" (Papert, 1980, Chapter 8, para. 20). This means that if activities can be designed that promote talking about what is being done (e.g., processes) rather than what was done (e.g., product), new ideas and thinking begin to take shape.

Embedded in constructionist learning activities is the idea of reflection. Papert (1991) uses the metaphor of soap-sculpture learning when he talks about what he wanted math learning to look like. That is, when someone creates a soap-sculpture, they use the available tools (e.g., carving tool), step back and look at what they have done, and then decide whether to move on or alter what they have done. This process of stepping back and looking is what is important here. However, it is unclear what specifically happens during this process. It can be assumed a reflection is happening, but it is unclear as to how this reflection impacts learning and engagement within the domain. The proposition being made in this chapter is that activity and speech should be coupled together. That is, the learner must not only be engaged in making something using the tools provided, but must engage in explicitly verbalizing their thinking (e.g., reflecting-in-action).

For Papert (1980), children should be in an environment where they can appropriate and use the available tools in their environment and reflect on what they have done to construct powerful ideas—new ways of thinking about the world—and therefore learn about the world around them (Papert, 1980; Bers, 2008). These powerful ideas, according to Papert, “have the capacity to help us organize our way of thinking” (p. 172). Intuitions have these same organizing capabilities.

The Importance of Intuitions

When people speak of intuitions, it is a term used to mostly describe a mystical phenomenon reminiscent of extra-sensory perception (e.g., a mother’s intuition). In the context of education, and more specifically learning and knowing, it is still given somewhat of a transcendental treatment. This means that researchers, and the learners themselves, cannot adequately explain how someone knows something without chalking it up to the learners’ intuition or common sense. However, this is an ineffectual explanation and does not explore the nature, use of, and benefits of intuitions.

Fischbein (1982) argues that intuitions are not merely a set of skills that are unconscious, but that intuitions are a form of knowledge based on previous experience. Schön (1983) insists that if intuitions are not recognized as valuable sources of knowledge, there may be difficulty in learning. These claims are significant because it gives intuitions legitimacy, especially in learning and knowing, that has not been valued in academic research. Research in physics between novices' and experts' use of intuitions (Smith, diSessa, & Roschell, 1994) asserted that novices have some very powerful intuitions about physics phenomena (e.g., force and friction) that help them approach and attempt to solve problems. Research also suggests that experts have these intuitions, but due to their expertise, it allows them to move more quickly to a solution of a problem (Smith, diSessa, & Roschell, 1994; Sherin, 2006). This is not surprising considering their expertise and their rich experiences within the domain. What is surprising is that they used some form of intuition in addressing and solving the problem in the first place.

Intuitions are undervalued in situated and sociocultural approaches to learning (c.f., Brown, Collins, & Duiguid, 1989; Wertsch, 1991) and not well articulated in constructionist approaches (c.f., Papert, 1980). For example, Papert (1980) suggests that intuitions are very important to learning but does not adequately define what intuitions are. Schön (1983; 1987) at least grounds his use of the term in a framework of comparing what he calls "technical rationality" (i.e., what colleges and universities teach) versus reflection-in-action (i.e., the ways in which we interact and solve everyday problems) in which intuitions are at the forefront. He places a greater importance that the professional's intuition has on their ability to do their job and notes that professionals in most, if not all, areas including music, architecture, education, and psychotherapy have a way of doing what they do that goes beyond a simple, step-by-step breakdown of the processes involved.

Intuitions, both of the professional and the learner, play a valuable role in both teaching and learning. When professionals (e.g., musicians/music teachers) fail to understand the unique intuitions students have about, for example, the structure of music—whether right or wrong—they resort to enforcing rules, language, and practices that conflict with what the learner already thinks they know. However, the learner may become so overwhelmed with new rules, language, and practices or may simply copy the professional word-for-word or action-for-action that learning becomes difficult.

The way to overcome this "learning bind" (Schön, 1987, p. 127) is for the learner to be (1) actively engaged in making something relevant to the discipline (e.g., music composition) and (2) enter into dialog and demonstration to communicate their thoughts related to the task(s) at hand. Allowing learners the chance to express their thinking can lead to improved learning (Chi, et al., 1989; Siegler, 2002). The research conducted in this chapter addresses these learning binds by allowing students the opportunity to make something while communicating their thoughts and thus reflecting-in and on-action.

One of the pitfalls with intuitions research is the lack of clarity or framing as to what intuitions are (c.f., Clement, 1993; Resnick & Wiliensky, 1998; Zietsman & Clement, 1997). Schön (1983) also lacks a clear definition at times when addressing intuitions. To address this, the following section provides a framework on how intuitions are viewed and applied in this chapter. This is accomplished first by providing a background as to what intuitions are by laying a foundation based on the work of Piaget (1947) and moving to more contemporary work done by diSessa (1993). Next, the issue of whether or not intuitions help a learner who does not have significant background information is addressed by suggesting a more creative domain like music may be a more appropriate domain to study intuitions. A review of intuitions in music is presented by highlighting the work of Bamberger (2013) and others (c.f., Swainwick, 1994; Wiggins, 2009).

Foundations of intuitions

There is quite the history regarding intuitions. What are they? How do they develop? Are they helpful? Do they even exist? The purpose of this section is not to dissect the philosophical implications of intuitions. This has been covered well by Noddings and Shore (1984), who trace the earliest accounts of intuitions and their impact on emotions, cognitions, and knowledge. However, the research in this chapter is concerned with the impact of intuitions on learning and the foundation presented as specifically related to the context of learning and education.

Some of the earliest writings of intuitions as they relate to learning came from Piaget (1947) while discussing a child's problem of conservation. For example, two rows of four cookies are placed in front of a child and the child is asked if there is the same amount of cookies in both rows (see Figure 6). The child will say that there are the same number of cookies in each row.

Figure 6. Example of Piaget's Conservation Task (part 1)

The second part of the task involves spreading the items in one of the rows further apart (see Figure 7).

Figure 7. Example of Piaget's Conservation Task (part 2)

The child is then asked if the top row (Row A) has more, the bottom row (Row B) has more, or are they both the same. The child—usually between the ages of three to about seven—will say that Row A (see Figure 7) has more, even though the amount has not changed. While most would consider this the wrong answer, Piaget (1947) noted, however, that the child's perception is correct. The issue relates to how the child's intuitive thought is centered on the strict relationship between the objects. The goal is to get the child to de-centralize her perception to the point that she constructs new relationships. This point is central to understanding intuitions and their impact on learning. That is, intuitions are not simply metaphysical knowledge structures that cannot be explained, but are powerful perceptual mechanisms that help in guiding our actions in the world.

Bruner (1977), while not explicitly citing Piaget, agreed with him and suggests that an intuition "…involves the embodiment or concretization of an idea…in the form of some sort of operation or example" (p. 103). This can be interpreted to mean that intuitions can guide what actions we take to navigate (e.g., problem solve) the world around us. He then expands this to say that intuitions allow us to view problems as whole structures which then afford us the opportunity to take several, non-analytic, approaches to solving problems. The connections to Piaget's view are apparent. The "whole structures" that Bruner (1977) discusses are in line with the Piagetian idea of perceptual relationships the child encounters. Being able to take several approaches to solving a problem, then, fits well with Piaget's idea of decentralizing the child's perception.

Both Piaget's and Bruner's notions of intuition provide a solid foundation with which to continue. Several researchers (Bowers, Regehr, Balthazard, & Parker, 1990; Burton, 1999; diSessa, 1993; Fischbein, 1987; Hogarth, 2001; Noddings & Shore, 1984) have investigated intuitions, and there are some commonalities based on the foundation presented earlier. They conclude that intuitions are based on our experience in the world; they provide a grounding with which we experience new things; and they play a prominent role in how experts approach and solve particular problems that arise during everyday activities.

Sense of mechanism and p-prims: Contemporary views of intuitions

Some of the most extensive research into intuitions was done by diSessa (1983; 1993) when he looked at engagement with physics phenomena. His investigations of intuitions are important because he provides a lexicon with which to understand intuitions better. When this lexicon is coupled with the foundation presented earlier, a more clear understanding of intuitions begins to take shape.

It is important to understand that what diSessa (1993) has done is present new ways of thinking about how these knowledge structures contribute to understanding. For this to happen, a better perspective of how intuitions develop and are organized is needed. His overall claim is that a person has a "sense of mechanism" (1993, p. 106) that allows for a sense of how things work and/or can work in the world. This sense of mechanism is not well organized but does not mean it is not useful. diSessa (1993) asserts that the sense of mechanism has "…a tendency to focus on static characterizations of dynamic events" (p. 105). This is directly related to what

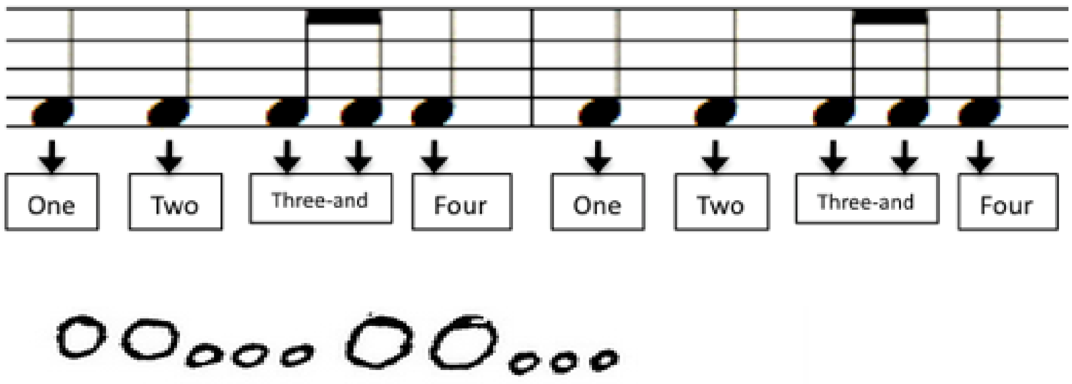
Piaget (1947) noted, intuitions are the focus of a person's schema and their perception of objects they have encountered.

This sense of mechanism is broken down even further into smaller knowledge pieces (diSessa, 1988; 1993) known as phenomenological primitives or "p-prims" (diSessa, 1993, p. 111). A p-prim is a small knowledge structure that helps a person make sense of some mechanism in the world around them. They are phenomenological because it is experienced in the conscious world and primitive because, for the learner, it is just how things are and needs no further explanation. P-prims are not complete knowledge structures that allow for recognition of some phenomena as a whole, nor are they so refined that they permit a complete and nuanced explanation of the phenomena (diSessa, 1993). They do, however, reside in a middle-level structure that "…should help activate other elements according to the context they specify" (diSessa, 1993, p. 112). What this means is that they guide our thinking and subsequent explanations of phenomena we encounter in the world. This middle-level structure will be important later when musical intuitions are discussed.

Musical intuitions

Intuitions in music have garnered some attention over the years (c.f., Swainwick, 1994; Wiggins, 2009). However, the most extensive research has been conducted by Bamberger (1972; 1976; 1995; 1996; 1999; 2000; 2003; 2013) in which she has concluded that even the most novice music learner has a sophisticated intuitive understanding of how music works. As an example, Bamberger (1975) presented listeners with a short rhythmic pattern (see Figure 8) and asked the listeners to draw what they had heard as a way to remember it later.

Figure 8. Short Rhythmic Pattern with Standard Music Notation and a Child's Drawing Representation Adapted From Bamberger (1975 p. 7)



The standard music notation for the example above shows two quarter notes, two eighth notes, and one quarter note repeated (sounds like "one, two, three-and-four"). She noted, however, that people tend to pay attention to the situational properties that are present in the music they are hearing rather than the fixed (e.g., rules) that govern the music. The drawing confirms this finding in that the listener groups the last three beats as if they represented the same value.

These type of findings led Bamberger to promote the notion that novice music learners begin at a mid-level structure; that is, what they understand and then move up and down a musical ladder (see Figure 1). Through their interactions with music, especially using the computer tool Impromptu[5], learners move to more detailed, or low-level, structures (e.g., notation, pitches, chords) as well as larger, or high-level structures (e.g., evaluation, developments, similarities and differences). This is because as they interact with the software, their hearing of a tune, and thus their intuitions, change. To make sense of what is going on, they must deconstruct the tune to lower-level structures and/or think about higher-level structures of the tune they are composing (Bamberger, 1999).

[5] Impromptu is the computer interface designed by Bamberger (2000) and used for this study. A full description is provided in the methods section of this chapter.

Pedagogically, this study emphasizes students starting out at this mid-level structure by allowing them to compose their own tunes. Using the structural musical ladder as well as concepts important for novice music learners to engage with (e.g., rhythm, style, mood) provides a way to understand better just how young learners utilize their intuitions while composing a tune.

Constructionist activities like composing a piece of music using a computer provides a fruitful area to investigate due to the opportunities for learners to express their thinking while engaged in the music making process. However, it is not entirely clear what the impact is on learners expressing a powerful idea while making something. While the role of reflection is of importance in constructionism (c.f., Kafai, 1995; Kafai & Resnick, 1996; Peppler & Kafai, 2007), the reflection that is being advanced in this chapter is one of more immediacy: the idea of reflection-in-action versus reflection-on-action (Schön, 1983; 1987).

Reflection-In-Action

The theoretical position to Schön's work (c.f., 1983; 1987) is one of differentiating, for example, what universities promote (e.g., how knowledge comes to be valid)—what he calls "technical rationality" (1983 p. 21)—and how professionals (e.g., experts) go about doing what it is they do in the world. This dichotomy—what universities promote and how professionals do their job—is the crux of what Schön is trying to elucidate. More specifically, how can professionals do what they do if they cannot specifically validate their actions through rigorous methodologies (e.g., performance and explanation) similar to what universities promote?

Schön (1987) advances the idea that the knowledge professionals have about what it is they do cannot be broken down into simple, step-by-step procedures because what the professional knows is located within the activities they engage in every day. A specific example given by Schön (1983) is that jazz musicians can improvise well because they have a formal knowledge of a musical lexicon (e.g., key signatures, scales, patterns) and can then use this lexicon to make contributions to the piece and thus understand the music that is happening as it is being heard. This happens because the musicians can reflect on what they are doing *while* they are doing it, known as reflection-in-action. Not only is it possible to see what professionals know (e.g., through their actions), but it is also possible for the professional to reflect-on-action through their self-explanations. Again, these explanations will not be a step-by-step recount and may be incomplete.

It is important to note that the ideas of reflection-in-action and reflection-on-action in this chapter are to be taken literally. That is the reflection-in-action happens while students are engaged in some music composition activity and talk about what they are doing at that give time. When students reflect-on-action, they do so after they have completed some action or activity. This distinction is important for two reasons. First, younger students (e.g., fourth-grade) are not professional musicians or composers. This does not mean, however, that using both reflection-in and on-action would not be useful. Second, because younger students have vast and varied experiences with music, their intuitions—what guides a professional's reflections—may be just as useful in coming to understand new concepts in a domain (e.g., music).

The research presented in the following sections is unique to the study of intuitions in three ways. The first is that the focus of the activity is placed on making an artifact (e.g., a musical composition) and the talk that emerges while making something. This type of activity allows learners to explore their intuitions through making and reflecting (Papert, 1980; 1991; Schön, 1987). And, since music making is more subjective than objective, learners can explore their intuitions without the fear of giving an incorrect response. Second, this research was conducted utilizing younger learners with very little to no formal musical knowledge or training of any kind. Previous studies on younger learners have shown that they can talk about phenomena, both scientific and arts related, in very sophisticated ways (Danish, Peppler, Phelps, & Washington, 2011; Downton, Peppler, & Bamberger, 2011) if the learning space encourages learning to become visible through, for example, self-explanations (Chi, et al., 1989; Enyedy & Hoadley, 2006). Other intuitions studies, even in music, have utilized older students in late high school and college (Bamberger, 2000; diSessa 1993; Smith, diSessa, & Roschell 1994). Finally, activities that emphasize reflection-in-action with younger and non-professional students in arts related activities are understudied in both the Learning Sciences and music education.

Methodology

Overview

The research in this chapter specifically addresses the impact of utilizing reflection-in-action and reflection-on-action approaches in a computer-aided music composition activities. More specifically I ask: (1) When fourth-grade students engage in both reflection-in and on-action, which type of reflection seems to promote greater domain engagement? How are the domain specific responses (i.e., advanced musical concepts) distributed during each activity? and; (2) Which types of design activities (open-ended vs. goal-oriented) are best suited to encourage more sophisticated discourse in the domain?

The data and subsequent analysis is drawn from two fourth-grade classroom (N = 36) working to construct musical compositions using the music learning tool Impromptu (Bamberger, 2000). The 20-hour curriculum, grounded in a constructionist (Papert, 1980) framework (Vygotsky, 1978), involved students reconstructing tunes, building rhythmic patterns to tunes, and composing their own tunes while engaged in a dialog with the practitioner and others in the class as well as working individually. The data are comprised of audio and video of the activities as well as written journals made by the students. Analysis techniques were fundamentally qualitative in nature, but certain parts of the data (e.g., number of musical responses) were quantized to help strengthen the claims made in this chapter (Chi, 1997; Creswell, 2009). Each of these is elaborated further in the following sections.

Setting and Participants

The study took place in a mid-sized school located in the midwest. The total population of the K-8 school is 253 students in which approximately 92% are European American/Caucasian, 8% ethnically diverse, and approximately 12% receiving free or reduced lunch. The selection of participants was done via a convenience sampling method. A convenience method is applicable in this instance because the fourth-grade students, who were the focus of the study, had already been formed (Creswell, 2009). Also, since one of the gaps in the literature is the age of the students and previous research (Downton, Peppler, & Bamberger, 2011) suggests younger students' intuitions may be beneficial, this group was ideal for further investigation.

Prior to any data being collected, IRB approval was granted (study # 1112007636). Also, prior to any data being collected, students were introduced to the study, explained their role in the study should they participate and their right to participate or not participate, and/or leave the study without any consequences. They were given assent and consent forms. As explained to the students, the assent forms were to be signed by the students should they want to participate and the consent forms were to be signed by their parent or legal guardian. There was a 100% return rate on both assent and consent forms. Therefore, students for this study were comprised of the entire fourth-grade population (N=36), 18 male and 18 female with an average age of 9.5 years. Students were not compensated in any way for their participation.

The intervention took place during the time in which students were participating in a Science, Technology, Engineering, and Mathematics (STEM) class. The overarching goal of this class was to allow students to engage with technology (e.g., iPads) to create some artifact (e.g., a instructional video), share that artifact with others, and reflect on the processes of making the artifact. In lieu of making a video, the teachers agreed the music composition activity would be a comparable activity.

Finally, the music teacher at the school indicated that activities in music class—one to two times per week for 30 minutes—consisted of singing activities, preparing for holiday programs, musical games and physical activities, and, if time permitted, unstructured playing time on musical instruments (e.g., drums, maracas, xylophone, piano). None of the activities mentioned allowed for the creation of a song within a structured environment, nor did the time allow for such instruction. However, during musical games, the teacher indicated that this would include concepts like duration, tempo, and notation (e.g., note writing on a staff).

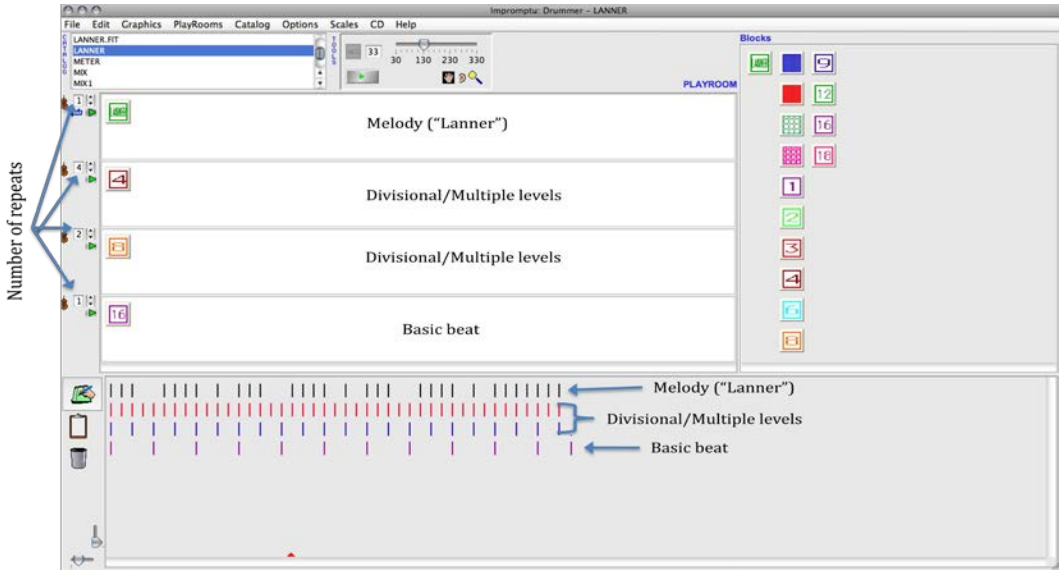
The Tool and Curriculum: Impromptu

The computer software Impromptu (Bamberger, 2000) was used throughout the study. Impromptu is a music learning tool that allows users to construct and manipulate tunes and rhythmic patterns using what is known as tuneblocks (see Figure 2). Users pick a tune from the library. Once the tune is selected, they are presented with an assortment of tuneblocks. These tuneblocks can be arranged in any order and repeated as many times as the user sees fit in the playroom. Users can also manipulate the tuneblock itself. For example, the user can click on the magnifying glass icon in the tuneblock editor, click on a tuneblock, and then proceed to change the pitch, duration, and/or rhythmic structure of the block.

This tool is unique, especially to this study, in two ways. First, Impromptu is *not* a composition tool, but a learning tool. Bamberger (2000) explicitly designed the software to allow users to question their intuitive notions about music and thus modify or change their intuitions based on their interactions with the musical tuneblocks. Second, and most importantly, the users begin at a mid-level structure or, as Bamberger (1996) argued, with what they already know. Studies of intuitions both within music and other domains suggest that the learner should be engaged with something familiar so that an intuition may be triggered when engaging with a problem (Bamberger, 1996; Bowers, et al., 1990; diSessa, 1993; Easen & Wilcockson, 1996; Fischbein, 1982; Laevers, 1998; Wiggins, 2009). Since Impromptu is about promoting conceptual knowledge (e.g., prompting mid-level structures and moving to high- and low-level structures), it is limited to how elaborate the construction of the composition can be. For example, being able to construct a tune using a pre-determined time signature (e.g., 4/4 time) is not possible. This is because the time signature is embedded in each of the tuneblocks. For example, if you have a tune that is in 4/4 time and you would like it to be in 3/4 time, you must edit the duration (timing) of the notes in each block to represent the 3/4 time.

The 20-hour curriculum for this project is taken from Bamberger's (2000) college-level curriculum and adapted for a fourth-grade classroom. The activities included Reconstruction, Construction, Building Meter, and the Final Project. Briefly, the Reconstruction activity involved choosing a particular tune from the Impromptu library (e.g., Hot Cross Buns) and using the given tuneblocks to put the tune back together. The Construction activity consisted of picking a pre-determined tune from the library and using the blocks to create a new composition. The tuneblocks for this activity were rhythmically and melodically balanced (e.g., tonal) and did not require the student to alter the individual tuneblock. The Building Meter activity consisted of choosing a pre-determined tune from the Impromptu library (e.g., Lanner) and building a beat to the tune using the given rhythmic tuneblocks (see Figure 9).

Figure 9. Impromptu Screenshot of the Rhythm Room While Building Meter for the Tune "Lanner"



The Final Project activity allows the students to make their own tune. This involves picking a tune from the Impromptu library that consists of blocks that are atonal (no melodic or rhythmic balance) and, should the student feel it is necessary, edit the given blocks and/or create new blocks in order to compose their music. A breakdown of the curriculum can be viewed in Table 1.

Each of the activities in this curriculum builds off each other. Bamberger (1995) has noted that when learners can engage with music in this way, they are having a conversation with the music. Each activity represents a conversation that increases in its complexity and involves components of the previous activity. For example, the Reconstruction activity is rather simple in that it asks the students to put a tune back together using the available tuneblocks, much like putting a puzzle together. However, sometimes the tuneblocks available to the learner do not seem sufficient to complete the puzzle. Yet, when students interact with the tuneblocks (e.g., have a conversation), they begin to realize the importance of repetition; that is, some tuneblocks can be repeated. The next activity, Construction, allow the students to make their own song and hopefully recognize and use repetition in their tune.

The Practitioner/Researcher

The teacher—referred to from this point on as practitioner—for the span of the curriculum was the researcher. This was decided on for two reasons. First, the researcher has over five years' experience in engaging younger students in music related activities. Based on previous study (Downton, Peppler, & Bamberger, 2011) that was the influence for the research conducted in this chapter, the researcher had carefully planned out how to engage students in the activities (e.g., asking how, what, and why questions). Also, the researcher understood the importance of allowing the students to explore their thinking without rushing, but also knew that keeping the activities moving was important to capturing quality data.

Also, the researcher has over 20 years' experience as an informally trained musician (e.g., garage bands) with formal, college training in music theory and composition and over 10 years professional experience with computer music production and composition. This was helpful for two reasons. First, due to the informal and formal music experiences, the researcher understood the importance of students expressing their thinking using the lexicon available to them. Research has shown than children make up their own terms when composing music and that this is an important area to investigate (Wallerstedt, 2013). Second, the experience in computer music production and composition allowed the researcher to make student thinking a reality during whole-class activities. Couple this with being able to navigate what students are saying while making the tune allowed the researcher to ask pointed questions and follow-up questions to the students.

Finally, the two fourth-grade classroom teachers and the STEM teacher were extremely supportive of the activities the students would be participating in and how the practitioner approached engaging the students in conversations. However, they felt that due to their lack of experience with both music and the technology involved (e.g., Impromptu) their participation would only hinder the overall goals of the project.

Daily activity – reflection-in-action/reflection-on-action

The practitioner would approach each activity consistently. Each activity was first done as a whole-class where the practitioner would facilitate the music creation and discourse (reflection-in-action), and then following the completion of that activity students would work alone (reflection-on-action). Students were given the full class time to work on their projects. For the reflection-in-action activities the practitioner would be at the front of the room with the Impromptu screen projected onto a Smartboard. The practitioner would then guide the students through the activity, allowing them to express their thoughts as they worked on the tune. The practitioner would ask students questions like “how do we want to start this tune out?” or follow-up questions like “why do you think the blue tuneblock should be after the red one?” Students were encouraged to talk with each other, try different solutions to the problems they were faced with, and make predictions based on their solutions.

Once the activity had been completed as a class, in the next class meeting students would work alone at their own computer using a different tune. At the beginning of each individual activity, students were given a notebook to keep a reflective journal of their composition they were making while working alone. While Impromptu incorporates a notebook feature, it was determined that sometimes the information does not save consistently and that using an "analog" notebook was more reliable. Attached to the inside cover of their notebooks were seven[6] guiding questions, adapted from Bamberger (2000, p. 29) that were meant to guide the students thinking. They were:

1. I wonder why that happened?
2. Why didn't that sound like I thought it would?
3. How would I describe what I just heard?
4. How would I describe what I thought would happen and what did happen?
5. How can I make sense of what just happened?
6. What could have made this piece better?
7. What would you have done differently?

These questions were similar to the ones asked during the whole-class activities. Prior to the beginning of the activity, the practitioner would remind the students what the goal of the activity was (e.g., reconstruct a tune) and what tune they should be using. They were also encouraged to look at the questions on the inside cover of their notebooks and use them to influence what they chose to write. Periodically throughout the activity, the practitioner would remind the students about their notebooks by saying "don't forget to write down your thinking in your notebooks if you haven't already". Students were not required to write in their notebooks if they did not want to. Both fourth-grade teachers suggested that if students were required to write, they would become frustrated with the activity and possibly not want to participate. To address this issue, students were told that what they wrote would not be seen by anyone but the practitioner and they would not be graded on issues like spelling, handwriting, or overall neatness of the entry in the notebook.

[6] Questions six and seven were additions to the original five questions from Bamberger (2000, p. 29).

Data Sources

There are two main sources of data that were used to answer the research questions addressed in this chapter: audio and video of the whole-class activities and the students' journal entries. RQ 1 and RQ 2 inquire about the domain engagement via musical discourse during different reflection practices and design activities. Therefore, both audio/video and students' written journals were used.

Audio and video data was captured using two high quality digital video cameras, each equipped with wide-angle lenses, a directional microphone, and a lavaliere microphone. Each camera was placed at the front of the room in opposite corners. This, along with the addition of the wide-angle lenses, allowed the all the students in the classroom to be captured on video. Instead of using the video camera's built-in microphone to capture audio, each camera was equipped with an audio signal mixer that allowed two separate audio signals (i.e., left side and right side) to be embedded onto the digital video that was captured. Attached to the top of both cameras was a high-quality directional microphone designed to pick up audio in the direction the microphone is pointing and at great distances. The signal from this microphone was plugged into the left side of the audio signal mixer. The one drawback to using this microphone, especially in a large room, can be ambient room noises that include computer fans and air conditioners. To address this issue, two high-quality and highly sensitive lavaliere microphones were placed in the room and their corresponding signals routed to the right side of each camera. These microphones are designed to pick up audio signals that are in relatively close proximity. The first microphone was placed at the front and center of the room while the other was placed at the rear and center of the room. This was done to pick up the audio that may be lost from the directional microphones that were not pointed in those directions. At the end of each whole-class activity, video and audio was downloaded to a secure external hard-drive and labeled for easy retrieval during the analysis stage.

The other data sources were the student journals. Students were given a notebook with blank, lined paper. During individual activities, students were asked, but not required, to write about the activity they were working on at the time. At the end of each individual activity, journals were collected from each student. Each student's entry was typed into a word processing document, labeled, and saved on a secure, external hard-drive.

Analysis

The activities participants engaged in are grounded in a constructionist framework (Papert, 1980). The key component in a constructionist activity is a focus on an artifact and how that artifact contributes to the knowledge that is being constructed (Kafai, 2006; Peppler & Kafai, 2007; Papert, 1993). The artifact in this chapter is the students' discourse during whole class and individual activities. The questions addressed in this chapter specifically deals with how intuitive thinking is used in the context of making something (e.g., music composition). Using both qualitative analysis techniques as well as a quantifying (e.g., counting) of qualitative data allows for further analysis using graphical representations and thus strengthening the claims being made (Chi, 1997).

Quantitative analysis included a variation of chi-square test called McNemar's test. This is essentially a chi-square test for repeated measures using a 2 x 2 table (Field, 2009). To satisfy the 2 x 2 contingency table needed for the test in RQ 2, data was collapsed into specific categories (e.g., type of activity, and type of reflection). To satisfy two categories for the student responses, mid-level structure responses were omitted from the analysis because the activities were designed to start off at a mid-level structure (e.g., what students already know). Therefore, the focus rests on the low- and high-level structures that students use in their reflections. Next, the four activities were collapsed into two categories. As mentioned earlier, the activities were either open-ended (i.e., Construction and Final) or goal-oriented (i.e., Reconstruction and Building Meter).

To support the quantitative data, qualitative excerpts are provided and were analyzed using a microdevelopment approach in which learning and development is investigated over relatively short periods of time (Granott & Parziale, 2002). Specifically, during each of the whole-class activities (Reconstruction, Construction, Building Meter, and Final), units of analysis were based on turn-taking events between practitioner and student or between student and student. For example, Table 7 shows an interaction between the practitioner and student:

Table 7

Example of Interaction Between Practitioner and Student

Line	**Speaker**	**Transcription**
1	Practitioner	Now what do you think?
2	Owen	I think the red ends it...I mean, actually, I think the blue ends it.
3	Practitioner	Why?
4	Owen	Because I just listened...because I remember the tune from the blue and then it sounds the same at the end.

Each line (or turn) is a unit of analysis. Analyzing a student's written journals took a similar approach in that each sentence was a unit of analysis. This was done because each new sentence could possibly constitute a new thought based on what the student was doing at the time. Also, each new sentence could have been a way for the student to answer the questions taped to the front of the notebook.

This type of approach is done for two reasons. First, these units of analysis allow for the investigation of the process of knowledge construction rather than a pre-post approach which can only claim that, for example, learning did happen, but cannot point to where or how this learning occurs (Granott, Fischer, & Parziale, 2002). More specifically, the claims made in this chapter about intuitions and their impact on learning while engaged in an activity are better suited using a microdevelopment approach because it highlights how and when people use these intuitions structures (Kuhn, 2002; Parziale, 2002). Second, Bamberger's claim (1996) that the novice music learner can move up and down the structural musical ladder if they start out with mid-level structures (e.g., intuitive) can be more closely investigated.

Coding the structural musical ladder

As Bamberger (1996) notes, the mid-level structures are the things in music that we already know about and pay attention to through our experience with music (e.g., listening). The figures and phrases, musically speaking, are short melodic and/or rhythmic passages that serve specific functions within the larger context of a tune or song. These figures and phrases are the tuneblocks in Impromptu. The functions of the tuneblocks can include how a song begins or ends (e.g., resolutions) or their stability or instability (e.g., melodic contour between blocks or rhythmic make-up). The entry-point is these familiar mid-level structures (tuneblocks), and when using Impromptu to make sense of music, it is "…much like the work of a composer in sketching out a piece" (Bamberger, 1996, p. 45).

When learners are making sense of their music, they begin to think about low-level, or more nuanced, structures of music. That is, they may hear a phrase that has a "wrong" note or is "faster" compared to the other phrases in the tune. They can then explore what makes a note "wrong" or a phrase "faster". Also, as they hear the music take shape they begin to move to high-level structures and evaluate the whole song, its development, and the similarities and differences their music has across time. Through this engagement, they begin to think and talk like a musician (Bamberger, 1996; Wiggins, 1994). Based on this, a series of codes was developed to analyze the audio/video and written journals of the students (see Table 8).

Table 8

Description of Structural Musical Ladder and The Specific Codes that Apply

Structural Musical Ladder	Code	Description
High-Level Structure *Overall organization of piece of music, motive, or phrase (e.g., tuneblock). Includes style, mood, and evaluation*	Style	Style refers to the genre (e.g., rock and roll) of the piece being heard or created.
	Mood	Mood refers to the feeling the piece of music has on the listener.
	Evaluation	Evaluation is an assessment of the piece being heard or created.
	Instrumentation	Describes the instrument(s) used in the piece of music.
Mid-Level Structure *Describes the ways in which elements of the tune function within a specific context. This can include melodic contour, repetition, rhythm, tempo, tonal center, resolution (i.e., endings), antecedent/consequence, and division of beats*	Repetition	Describes/notices how patterns (e.g., tuneblocks) repeat
	Rhythm	Describes rhythm of the piece and how the beats work together to form the rhythm.
	Tempo	Describes the speed of the piece.
	Tonal Center	Describes the overall tonality of the piece. That is, the notes in the piece complement one another and are pleasing.
	Resolution	Describes the ending of a tune or how a tune should end/resolve.
	Antecedent/ Consequence	Describes a "question and answer" functionality of the music. Usually happens when one phrase ends with either a high or low note (or sequences of notes) and the subsequent phrase

		ends with the opposite of the preceding phrase.
	Division of Beats	Describes how the beats in the music are divided up.
	Melodic Contour	Describes the relationship of the notes and how they work together in the context of what is being heard / created.
Low-Level Structures *A deconstruction of mid-level structures including pitches, chords, and metric values.*	Pitches	Describes or demonstrates (e.g., hums) the individual notes and or sound of individual notes being uses.
	Chords	Describes the use of chords (e.g., two or more notes played together) in the tune being created.
	Interval – Melodic / Rhythmic	Describes or demonstrates how melodic (e.g., pitches) or rhythmic elements are divided.

These codes were derived not only from Bamberger (1996; 2000; 2013), but are common themes found in literature related to music composition, especially for children who have no formal domain knowledge or training. For example, Mellor (2000) reports that when people respond to music they hear, they focus on musical elements (e.g., pitch, duration, tempo, structure), style (e.g., genre), mood, and an overall evaluation of the piece. Others (c.f., Burnard, 2000; Campbell, 1998; Hargreaves, 1986; Kartus, 1989; Upitis, 1990) have expressed similar thoughts that form, structure, development, and instrumentation are important concepts when composing a piece of music when the composer lacks the specific domain knowledge (e.g., not formally trained).

Once all the audio/video and journals were coded, two researchers who were familiar with the study but unfamiliar with the coding scheme were given a coding guide to review and determine the reliability of the codes. They were then given transcripts containing short interactions (three to five minutes) and shown the corresponding video to follow along and code as well as a selection of journal entries. Sometimes, two to three passes of the video were done to ensure the raters had completely coded the data. Codes from both raters were compared to the initial coder using Chronbach's Alph and found 94% agreement indicating the coding scheme to be reliable.

To address issues related to validity, strategies have been used to make sure the data presented is accurate. First is the use of multiple data sources, multiple individuals, and time points (e.g., audio of conversations and written journals over time). This allows for themes (e.g., codes) in the data to be viewed as valid, and thus, trustworthy (Creswell and Clark, 2011). Second, providing rich descriptions of the data allows the reader to get a better sense of what exactly was happening during the data collection process (Creswell, 2009). Finally, other researchers who are familiar with this research and/or familiar with both qualitative and quantitative research methodologies have reviewed and provided feedback of the data and analysis (Creswell, 2009; Creswell & Clark, 2011).

Findings

RQ 1 - When fourth-grade students engage in both reflection-in-action and reflection-on-action, what is the relationship between domain engagement (e.g., musical discourse) and the specific reflection? How are the domain specific responses (i.e., advanced musical concepts) distributed during each music making activity?

An important metacognitive strategy for students to practice is reflection (Bransford, Brown, & Cocking, 2000; Sawyer, 2006) because it allows the learner to not only engage with the domain at a deeper level, but promotes learning to learn (Papert, 1980). The study in this chapter advances a curricular and pedagogical approach that distinguishes between two types of reflection: reflection-in-action (i.e., whole-class activities) and reflection-on-action (i.e., individual activities). An important aspect to these reflections is intuitions. These intuitions can act as guides in order for the learner to engage more deeply with the domain. The purpose of this question is to better understand any relationships between the type of reflection students engage in and the types of musical discourse that is used during those reflections.

The reflection-in-action data was gathered during each of the whole-class activities (Reconstruction, Construction, Building Meter, and Final Project). These activities were video recorded and later transcribed and coded for instances when the discourse would show evidence of the structural musical ladder (e.g., high-, mid-, and low-level structures). Similarly, during reflection-on-activities in which students worked alone and wrote in their journals, journals were collected at the end of each activity and coded based on the discourse the student used. Quantitative counts of each type of response (i.e., high-, mid-, and low-level) were generated and used in the analysis to answer this question.

Table 9 is broken into three separate sections: reflection-in-action, reflection-on-action, and a combination of reflection-in- and on-action. The first column is the type of responses related to the structural musical ladder. Within these cells, there are three numbers to understand. The first number—the numerator—is the total number of responses for that response. So, for example, in the first cell, there are a total of 65 high-level structure responses given during the reflection-in-action activities. The denominator is the total number of overall responses—the sum of high-, mid-, and low-level responses—during the specific reflection. Again, looking at the first cell, there are 283 responses given during the reflection-in-action activities. Dividing the total number of specific structural musical ladder responses to the overall musical responses generates the percentage.

Numbers were then further broken down by the specific activity (e.g., Activity 1) where the numerator is the number of specific structural musical ladder responses given during the specific activity, the denominator is the total number of responses given during that specific activity, and the percentage is calculated by dividing the two numbers. This allows for greater insight into how the responses break down over time based on the reflection type (i.e., in- and on-action) and across each activity. To better understand the relationship between the type of reflection and the discourse, each section of Table 9 will be addressed and then compared.

Table 9

Total Number of Responses Given at Each Activity and the Percentage (Number of Responses at Each Activity / Total Responses Over the Course of Curriculum)

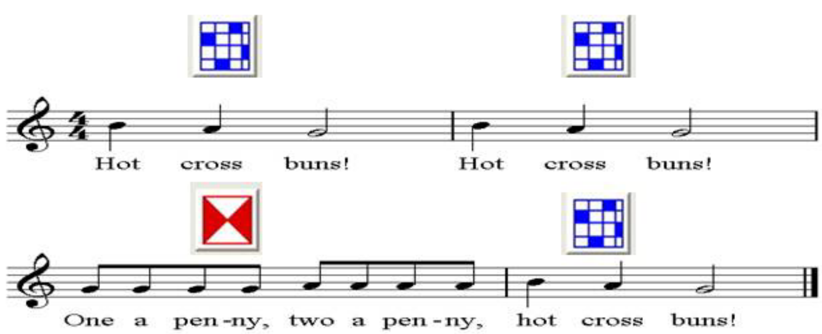
	Structural Musical Ladder	Activity 1: Reconstruction	Activity 2: Construction	Activity 3: Building Meter	Activity 4: Final Project
REFLECTION -IN-ACTION	High-Level Structures N = 65/283 (22.96%)	2/43 (4.65%)	29/106 (27.35%)	3/51 (5.88%)	31/83 (37.34%)
	Mid-Level Structures N = 180/283 (63.60%)	36/43 (83.72%)	66/106 (62.26%)	46/51 (90.19%)	32/83 (38.55%)
	Low-Level Structures N = 38/283 (13.42%)	5/43 (11.62%)	11/106 (10.37%)	2/51 (3.92%)	20/83 (24.09%)
	N = 283/473 (59.83%)	43/283 (15.19%)	106/283 (37.45%)	51/283 (18.02%)	83/283 (29.32%)
REFLECTION -ON-ACTION	High-Level Structures N = 84/190 (44.21%)	6/24 (25.00%)	37/60 (61.66%)	7/42 (8.33%)	34/54 (40.48%)
	Mid-Level Structures N = 80/190 (42.10%)	15/24 (62.50%)	27/60 (45.00 %)	24/42 (30.00%)	14/54 (17.50%)
	Low-Level Structures N = 26/190 (13.68%)	3/24 (12.50%)	6/60 (10.00%)	11/42 (42.31%)	6/54 (23.08%)
	N = 190/473 (40.16%)	24/190 (12.63%)	60/190 (31.57%)	42/190 (22.10%)	54/190 (28.42%)

It was observed that students engaged in musical discourse related to the structural musical ladder 283 times during reflection-in-action (e.g., whole-class activities). The greatest proportion were mid-level structure responses, which garnered 63.60% of the total. The high-level structures were used 22.96% of the time and low-level structures 13.42% of the time. It is not overly surprising that mid-level structures dominated the discourse since the activities were geared toward that type of discourse. The importance resides in whether the students would engage in high- and low-level structure discourse over the course of the activities, and it was observed that they did.

To demonstrate what this looks like in context, an interaction from the "Reconstruction" activity (day 1) is presented. For this particular example, students were asked to put the tune Hot Cross Buns together using the tuneblocks given. This was the first whole-class activity for the students. Prior to listening to any blocks, the researcher informed the students that there were no right or wrong answers, they would not be graded on anything, and everyone's input was valued.

Hot Cross Buns is a simple, four-bar tune that consists of three notes (B-A-G) in which bars 1, 2, and 4 repeat. This is represented in Impromptu as the blue tuneblock (see Figure 10).

Figure 10. Traditional Notation of Hot Cross Buns with Corresponding Tuneblocks



The overall goal was for the students to recognize the importance that repetition plays in musical structures. This excerpt was taken at the beginning of the activity just after the students heard Hot Cross Buns and were then asked how many blocks they think would be needed to put the song together (see Table 10). Notice how in the beginning there seems to be some guessing going on with the students as some of them are able to see the practitioner's computer screen. Others seem to be calling out numbers looking for confirmation from the practitioner on whether or not they are correct.

Table 10

Transcription of Practitioner and Student Interaction During "Reconstruction" Activity with Interpretation.

<table>
<tr><th>Line #</th><th>Name</th><th>Transcription</th><th>Interpretation</th></tr>
<tr><td>1</td><td>Practitioner</td><td>So we know what Hot Cross Buns is, how many blocks do we think are there?</td><td rowspan="7">Practitioner is engaging students to think about music can be divided.

This is a low-level structure response in which Graham demonstrates, vocally, what his intuitive understanding of how the tune is divided.</td></tr>
<tr><td>2</td><td>Class</td><td>Four</td></tr>
<tr><td>3</td><td>Practitioner</td><td>(pointing to Graham) Why four?</td></tr>
<tr><td>4</td><td>Graham</td><td>Cause I looked on the screen and it has four things…like "duh, duh, duh…duh duh…"</td></tr>
<tr><td>5</td><td>Practitioner</td><td>(interrupting) There are not four blocks. That's what you get for looking on the screen…</td></tr>
<tr><td>6</td><td>Graham</td><td>…Five blocks</td></tr>
<tr><td>7</td><td>Practitioner</td><td>No, there are not five…</td></tr>
<tr><td>8</td><td>Ali</td><td>Three</td><td rowspan="4">Students are giving mid-level structure via general intuitive responses.</td></tr>
<tr><td>9</td><td>Madelyn</td><td>Six</td></tr>
<tr><td>10</td><td>Practitioner</td><td>No, don't look at the screen. How many blocks do we think there are?</td></tr>
<tr><td>11</td><td>Gabriel</td><td>Three blocks</td></tr>
<tr><td>12</td><td>Practitioner</td><td>Who said three?</td><td rowspan="3">Practitioner tries to engage student by asking them to elaborate on why they chose their answer.</td></tr>
<tr><td>13</td><td>Gabriel</td><td>(Raises Hand)</td></tr>
<tr><td>14</td><td>Practitioner</td><td>Why do you say three Gabriel?</td></tr>
</table>

15	Gabriel	Ummm…I really…ummm…by what he said (looking at Graham) I just guessed off of it, just lower than his…what he said, because he said five and I said three, so…	Gabriel is unable to do so and admits he was guessing. This was rare amongst the students.
16	Practitioner	Ok…so you just guessed based on what he said… (*Mya raises hand)*	
17	Practitioner	(to Mya) How many blocks do you think there are?	
18	Mya	Three	Mya gives a mid-level structure responses. However, in order to explain herself, she changes the lexicon to try and explain herself further. The tune we heard did not have an audible beat (e.g., drum) but did have different melodic patterns.
19	Practitioner	Why three?	
20	Mya	Because there are three different beats	
21	Practitioner	What do you mean by beats?	
22	Mya	There are different tones of music	
23	Practitioner	(to Gabe) How many blocks do you think there are?	Again, practitioner engages the student in explaining themselves further. Gabe gets at the central point, using a mid-level structure response, in that repetition is what is important here. He indicates that some blocks have the same pattern that can be repeated.
24	Gabe	Three	
25	Practitioner	Why three?	
26	Gabe	Because it kept having the same sounds and blocks over and over again.	
27	Practitioner	Very good. These are all great answers… (to Ali) How many blocks do you think there are?	
28	Ali	Two	Much like Gabe, Ali suggest that there are only 2 blocks because they can repeat over the course of the tune.
29	Practitioner	Why two?	
30	Ali	Because it's just repeating it.	

At the beginning of the conversation, Graham, who could see the computer screen from his seat, noted that there were four blocks. While his eyes may have deceived him, his ears were helping him explain his reason. The "four things" (line 4) he speaks about could be the four bars in Hot Cross Buns and that is how he has organized the song in his head. He is clearly thinking about the structure of the whole tune and how each part fits to make a whole. This is further observed when he begins to hum the different parts of the tune. This demonstrates the moving from the mid-level structure (phrases) to low-level structures (metric values).

After a few exchanges with students who were randomly shouting out answers (lines 8 – 16), Mya suggest there are three blocks because of the different beats of music (line 18). At this point, she seems to be thinking about how the music is segmented based on the rhythmic patterns in the music (e.g., the beats). She is using the musical term "beats" to reason her answer (line 20). It is unclear at this point what she means by the term "beats" but it obviously serves a purpose for her. The practitioner asks a follow-up question to get a better determination of what she means by "beats" (line 21). She re-words her description to say "tones" instead of beats (line 22). It is possible that she organized the music identifying a beginning, middle, and end. In the case of Hot Cross Buns, it does have a beginning (Hot cross buns! Hot cross buns!), a middle (One a penny, two a penny), and an end (Hot cross buns!). This is the "three different beats" (line 20) or "tones" (line 22) that Mya is speaking about.

Gabe agrees with Mya that there are only three blocks (line 24) but his reason differs in that he talks about the repetition (line 26). It is possible that he, like Mya, has organized the music as a beginning, middle, and end structure, but has noted repetition, which is an important concept in music making. Finally, Ali suggests there are only two blocks (line 28) "because it's just repeating it" (line 30). Again, Ali has noted the importance of repetition in the song structure.

The uniqueness of the Impromptu software in this activity is that it forces the user to use not just their eyes, but their ears as well. It is clear that from this excerpt, even when Graham's eyes deceived him, his ears took over to make sense of what he was hearing. Others in the class, through constant engagement from the practitioner, began to think and re-think about the question (how many blocks are needed to make Hot Cross Buns?), which forced them to reflect on what they heard and how the tune could be organized.

Quantitatively, it was observed that the mid-level structure responses were most prevalent in the discourse and this was noted in the excerpt. Movement up and down the structural musical ladder was sparse in this particular excerpt other than Graham's demonstration of how the tune is categorized (line 4) and the bulk of the conversation stayed at the mid-level. This is not a bad thing. It is important to remember that these students had no formal music training and were making their own music for the first time and that talking about the music at the mid-level is productive.

Conversely, when students reflected-on-action (e.g., worked alone and wrote in their journals), students engaged in high-, mid-, and low-level responses 190 times over the course of the activities. The greatest proportion of responses was observed with 44.21% of high-level structures, while low-level responses were 13.68% of the total responses given and mid-level responses accounted for 42.10%. The larger proportion of high-level structure responses to mid-level structure responses is different than what was observed during reflection-in-action and will be further discussed later in this section.

Table 11 shows three different journal entries from student journals. Note that Graham's writing centers on high-level structure responses (e.g., how his tune sounds or will sound). This was typical for the students' journal entries. Two other examples are given as a means of contrast to show other types of discourse.

Table 11

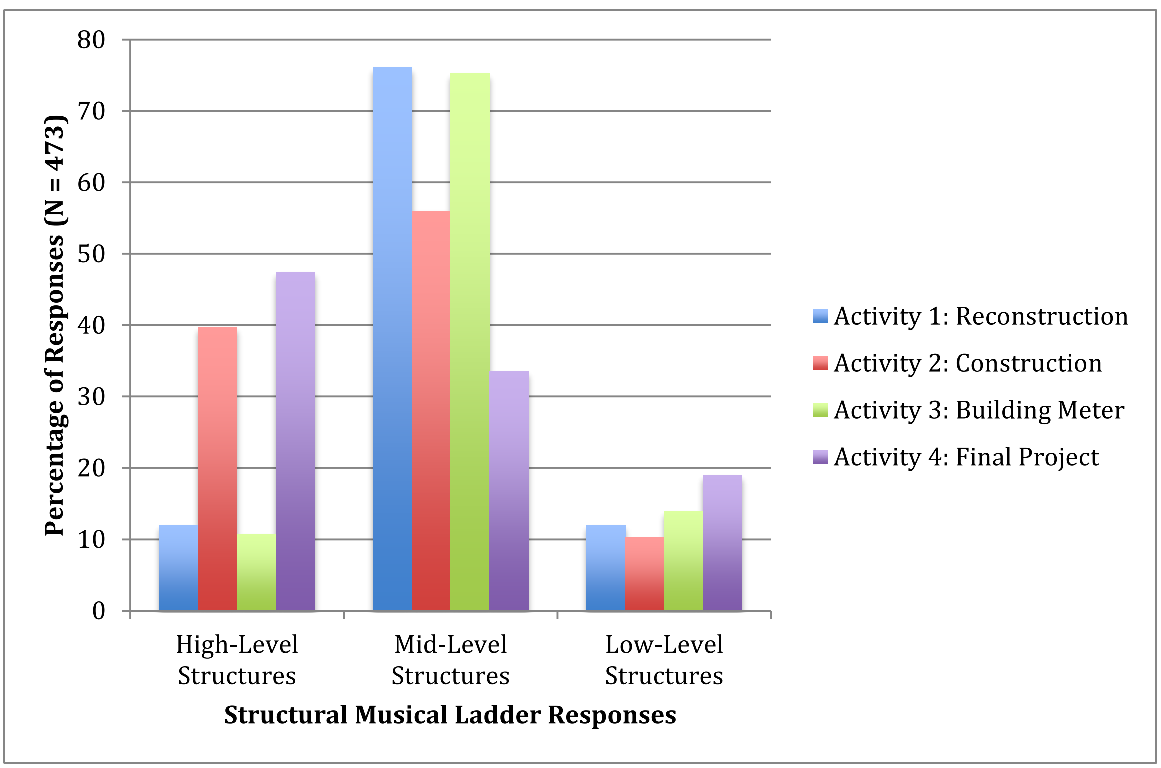
Student Journal Entries for the "Reconstruction" and "Building Meter" Activities with Interpretation

Student	Activity	Journal Entry	Interpretation
Graham	Reconstruction	I put the triangle the red triangle second and the other green triangle then it sounded right.	These are all high-level structure responses in which the focus is on how the overall tune sounds within the given context.
		The whole song block I played a lot then I said my song was right.	
		I wonder why 2 red triangles went together on this but not on hot cross buns.	
Gracie	Reconstruction	1. I just heard that the sound for the block with the green triangle went up and then went down.	These are mid-level structure responses because of the focus on the melodic contour of the tuneblocks she is describing.
		2. I thought the red block would go down than up but it went down.	
Mya	Building Meter	It's duepuil [*sic*] because it has it strats [*sic*] with 2 and add 2 more wich [*sic*] is 4 and had 2 4s wich [*sic*] is now 8 and add	This reflects both mid- and low-level structures due to the focus of the division of the beats and the specific mention of the intervals used to make the beat.

Graham is thinking about the structure of the tune he is putting together when he gives his directions of how he put the song together. However there was no further explanation, inferences, or justifications written down. As was observed quantitatively in Table 9, reflection-on-action activities seemed to promote more high-level structure responses. Gracie's focus is on the mid-level structure that includes the melodic contour of the blocks she is using. Specifically, she is trying to match what she hears in the blocks with attaining the end goal of putting the song together in the correct way. Mya uses both mid- and low-level structures in her response when building a beat to her tune. She concentrates on the division of the beats (mid-level structure) as well as the metric intervals (low-level structure) used to accomplish her goal.

Now that there is a better sense of the relationship between the type of reflection and domain engagement (e.g., musical discourse), the attention shifts to how the discourse (i.e., type of responses) is distributed over time. Specifically, there needs to be a better understanding of any trends within and across the activities related to the discourse. To get a better sense, Figure 11 plots out the total percentages (Y axis) of high-, mid-, and low-level responses (X axis) (see bottom third of Table 9) over the entire curriculum in both reflection-in- and on-action.

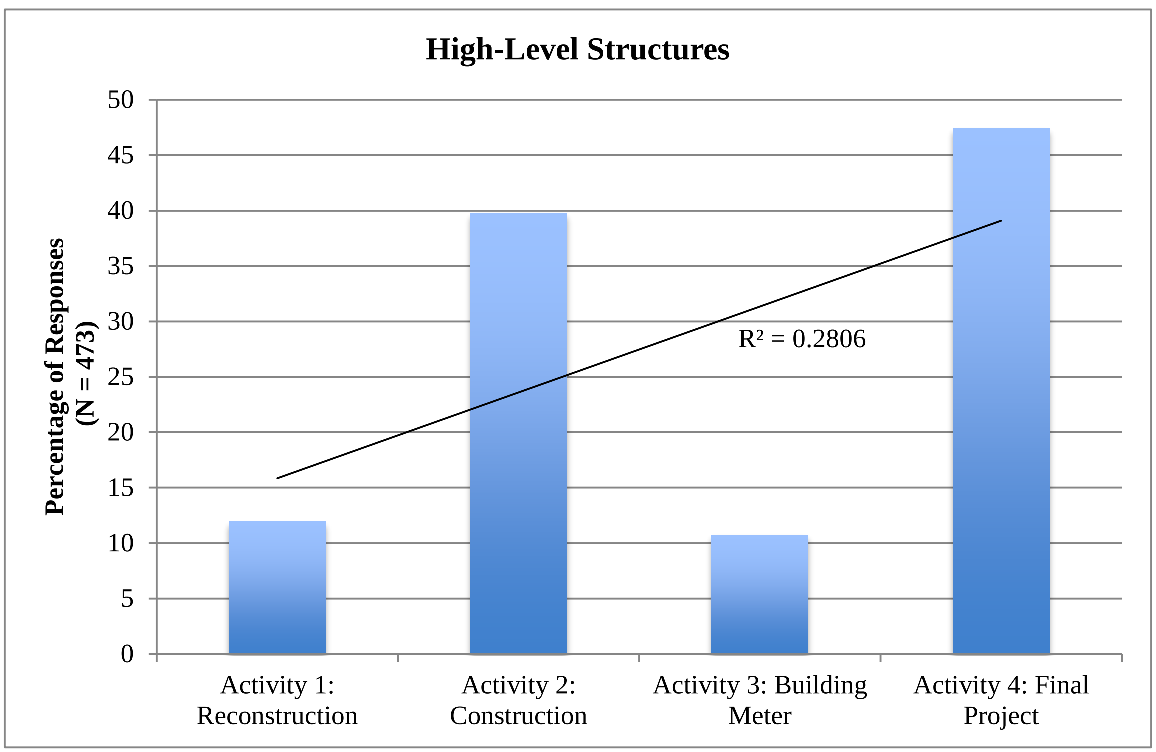
Figure 11. Percentage of Structural Musical Ladder Responses Given at Each Activity.



Overall it can be observed that high-level and low-level structure responses show upward trends while mid-level structures decline. To see this more clearly, each response type (e.g., high-level structures) was isolated and visually represented by a graph with a trend line showing the strength of association (i.e., R^2 value)[7]. First, a presentation of the upward trends in both high- and low-level structures is presented. There will then be discussion of the declining trend of mid-level structure responses.

Looking at the high-level structures, it is observed that an upward trend is taking place. That is, as time progresses, the percentage of students high-level responses are increasing. Figure 12 isolates the percentage of high-level structure responses (Y axis) at each time point (X axis) and adds a trend line in order to better visualize this trend.

Figure 12. Percentage of High-Level Structure Responses at Each Time Point With Trend Line.

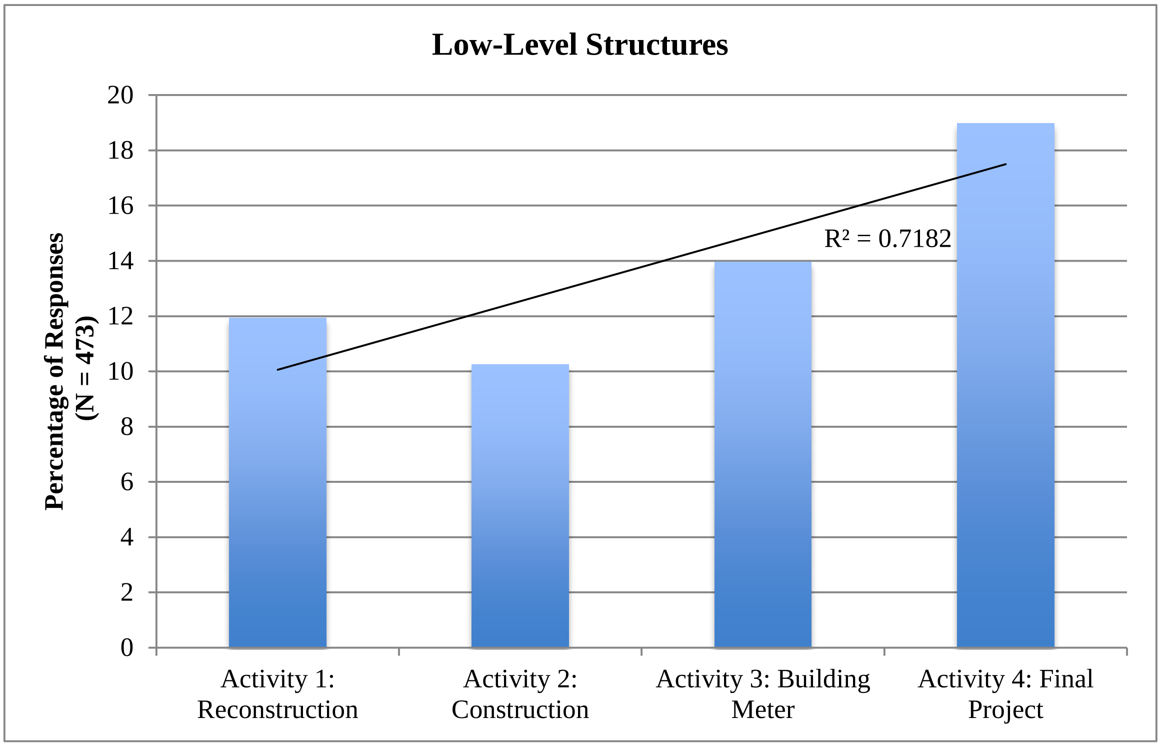


[7] The purpose of the trend line is descriptive only as the purpose of the question was to investigate the distribution of responses within and across activities. The R^2 value is meant to give a numeric representation to the strength of association.

There is a clear upward trend observed for Activities 1, 2, and 4 indicating that as time progresses, students engage with more high-level structure responses. Notice the drop-off in high-level structure responses during Activity 3, specifically, this activity is concerned with constructing a beat to a predetermined melody or tune (e.g., Hot Cross Buns). Therefore, the goal of the activity is not to construct something that is aesthetically pleasing or creative but to simply find out what works. Specifically, determining what meter is the tune in (e.g., duple or triple) and constructing a beat that fits within those parameters. This does not mean, however, that this activity should not be considered in future curricular designs. What may need to change is allowing students to first construct a melody or tune of their own and then construct their beat. This may encourage them to think about how their designs (e.g., beats) fit in with the genre, style, or mood (e.g., high-level structures) they want to create.

Additionally, low-level structures exhibit an upward movement over time. Figure 13 isolates the percentage of low-level structure responses (Y axis) at each time point (X axis) and adds a trend line to better visualize this trend.

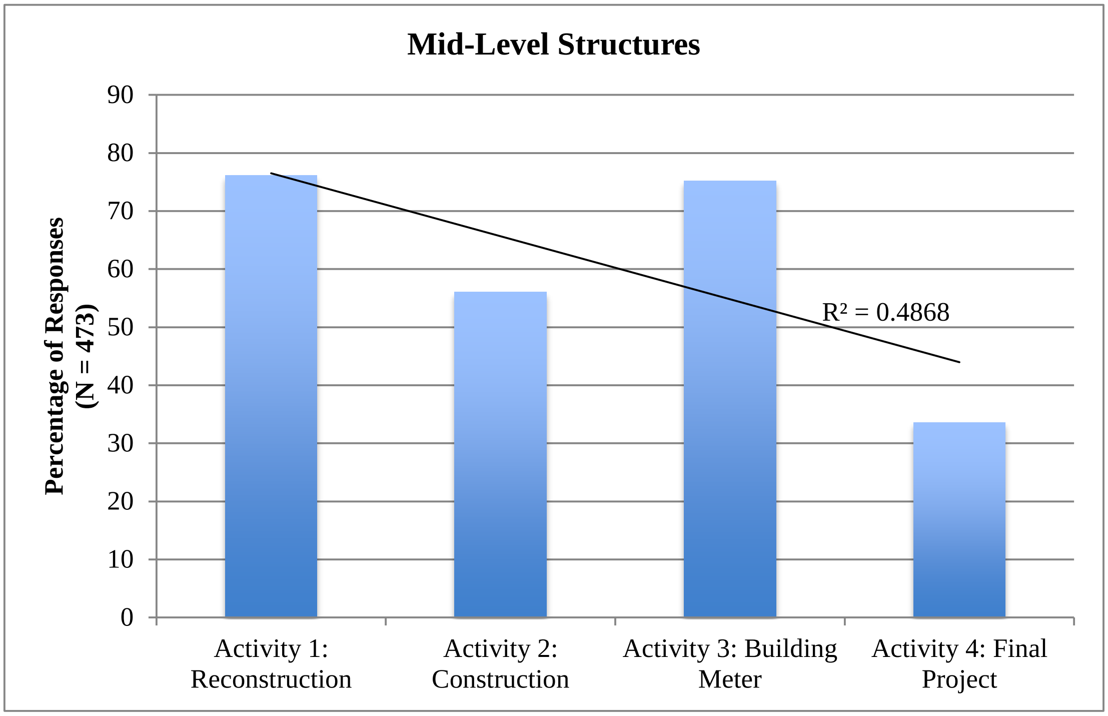
Figure 13. Percentage of Low-Level Structure Responses at Each Time Point With Trend Line.



This upward trend in the low-level structure responses is the most significant for two reasons. First, low-level structures deal with concepts that are related to music literacy (e.g., notes, pitches, metric and melodic intervals) and are highly valued by music educators (NAfME, 2013). Second, these students had no formal training in music, so the knowledge about these concepts is intuitive rather than explicit. This suggests that it may be more beneficial to start students with activities that promote more design (e.g., composition) rather than focus on traditional music literacy concepts. The design aspect allows students to explore low-level structures through their intuitions and then decide whether these intuitions were useful or not. Teachers can listen to both their students and the compositions to determine what students understand and where they might be having trouble.

Finally, the decline over time in mid-level structures is observed. Figure 14 isolates the percentage of mid-level structure responses (Y axis) at each time point (X axis) and adds a trend line to better visualize this trend.

Figure 14. Percentage of Mid-Level Structure Responses at Each Time Point With Trend Line.



The decline is important to note because it would indicate that the more students engage in the practice of designing their own compositions, their attention moves from the mid-level to more salient features that include low- and high-level structures. Essentially, students begin to trust their intuitions and use them as a mechanism to construct new knowledge that guides the music composition (e.g., design) process. The reason for this could be because the students are becoming more adept at becoming composers and the mid-level concepts become more of a guide of how to proceed in composing a piece of music rather than a prescribed model of how the piece should be composed.

The purpose in investigating the discourse in relation to specific types of reflection across time is to advance a pedagogical practice that encourages students to use their intuitions while engaged in designing an artifact (e.g., composing a tune). This is due to the claims that metacognitive strategies that include reflection are essential for learning (Bransford, Brown, & Cocking, 2000) and that intuitions are a driving force of these reflections (Schön, 1983). However, research investigating the relationships between intuitions and specific types of reflection is lacking in the literature. Also, reflection, both in- and on-action, is normally viewed as a practice related to experts/professionals and how they engage their domain. It is unclear to what these practices might look like with younger, non-experts and whether it was advantageous to encourage these reflective practices.

Using the structural musical ladder as a basis for the discourse and the different classroom pedagogical practices (e.g., whole-class vs. individual) as the types of reflection, the findings for this particular question show that both reflection-in-action and reflection-on-action activities promote a musically sophisticated discourse as indicated by the numbers in Table 9. This shows that engaging students in activities that encourage reflection-in-action promotes more discourse; that is, students tend to talk more during these reflection opportunities.

While not proportionally equivalent, reflection-on-action activities promoted a discourse in which students were thinking about their designs in relation to the norms and practices of what it means to write a piece of music. More specifically, when students, for example, want to make a song that sounds “techno”, that is a problem to be solved. They have an idea as to what “techno” means and they can judge what they are building in accordance to what is considered “techno”.

It was also observed that the distribution of responses over time indicated that there were upward trends in both high- and low-level structures and a declining trend in mid-level responses. As Bamberger (1996) posited, starting at the mid-level allows learners to move to higher and lower-level structures. These findings provide quantitative evidence of this trend. That is, as time progresses, students seem to move more freely to higher- and lower-level structures.

While analyzing the relationships between discourse and reflection types, it was observed that the type of activity (e.g., Construction) seems to be having an impact on the discourse that is taking place. Specifically, two of the activities (Activity 1 and 3) are considered goal-oriented activities. That is, the purpose of the activity was to solve a specific problem (e.g., reconstruct a tune or build meter to a tune). These activities were chosen because they introduce students to important concepts (e.g., repetition; rhythmic intervals) and how those concepts function within specific musical contexts.

The other two activities (Activity 2 and 4) are open-ended activities. These activities afford the student the possibility to make creative decisions without any constraints. This is important to understand for two reasons. First, some music educators and researchers (c.f., Bamberger, 2013; Green, 2002; Wiggins, 2009) have advocated for a pedagogy that engages students in activities that are meaningful to them—what they already know (e.g., mid-level structure)—and then moving to more nuanced or formal concepts like notation and performance (e.g., low-level structures). One way to do this, as suggested in this study, is through computer-aided music composition activities. Unfortunately, composition is largely undervalued in music education because teachers may not be adequately trained in how to compose, how to teach composition, and what outcomes to look for from their students (Hickey, 2012). Also, of the nine standards in music education, only one advocates for composing that includes certain restrictions (e.g., use of certain form, type of notes/rests) (NAfME, 2013).

Second, and most important, the pedagogical approach promoted in this chapter encourages students to engage in the practice of composing music akin to how the professional composer works. While the professional composer has a formal knowledge base with which to work, their practice of reflection-in-action, via their intuitions, also contributes to how they approach their craft (Schön, 1983). The activities in this study also encourage students to use their intuitions while they are engaged in composing a piece of music. Previous research has shown that students as young as fifth-grade with little to no formal knowledge of music can engage in a discourse similar to that of a professional musician (Downton, Pepper, Bamberger, 2011). What is being noticed within this data, and will be examined in more detail in the following section, is that the type of activity (i.e., creative vs. open-ended) may impact deeper engagement in the domain.

RQ 2 – What impact does the type of activity have on student's sophisticated discourse in the domain?

To investigate the impact the type of design activity has on domain discourse, the four different activities were collapsed into two categories: (1) goal-oriented activities (i.e., Reconstruction and Building) and (2) open-ended design activities (i.e., Construction and Final Project). The purpose of collapsing the activities in this way is to provide a statistical analysis to better understanding of what types of design activities promote domain discourse. Having this information can inform the teacher of the type of activities they should focus on depending on their intended goal. For example, if the goal is to promote more high-level discourse (e.g., thinking about the overall tune that is being composed) the analysis presented here can inform what specific activity will achieve that outcome. Finally, mid-level structure responses were removed from the following analysis. Because the activities were designed specifically to engage students at the mid-level structure, it would reason that the discourse would reflect this. The mid-level structure is what students already know and know how to do (Bamberger, 1996). The importance is to highlight the more sophisticated musical discourse the students engage in (e.g., high- and low-level structures) while composing a tune. That is, through their engagement, they are learning about concepts that were not formally taught but have emerged through their engagement in the design (i.e., composition) process.

To see this more clearly, a 2 x 2 table was produced (see Table 12). The purpose of the table is to determine if the type of design activity (goal-oriented vs. open-ended) has any impact on the students' musical discourse. To statistically analyze this, a variation of the Chi-Square test called McNemar Test was conducted. The McNemar is a Chi-Square tests for repeated measure designs that elaborates on whether the association between response type and activity was significant (Vogt, 2009). By computing an odds ratio, a more clear distinction is made on just how the activity impacts the type of response (e.g., an interaction).

Table 12

Crosstabulation Table with Type of Musical Discourse (i.e., High- and Low-Level Structure Responses) and Type of Design Activity (i.e., Goal-Oriented vs. Open-Ended)

			Type of Design Activity	
		All Design Activities	Goal-Oriented Design (Activities 1 & 3)	Open-Ended Design (Activities 2 & 4)
Type of Musical Discourse	Low-Level Structure	64	21/64 (32.81%)	43/64 (67.18%)
	High-Level Structure	149	18/149 (12.08%)	131/149 (87.91%)
Total		213	**39/213 (18.3%)**	**174/213 (81.7%)**

The McNemar Test found that there was a significant association between the type of musical discourse and the type of activity ($p < .002$)[8]. Essentially, open-ended activities seem to be better suited for encouraging more sophisticated musical discourse. Looking at the numbers further, it can be seen that during open-ended activities, students talk about high-level structures 87.91% of the time as opposed to 12.08% of the time during goal-oriented activities. Similarly, and more significantly is that students talk about more nuanced musical features—low-level structures—67.18% of the time during open-ended activities opposed to just 32.81% of the time during goal-oriented activities. To fully appreciate the impact the type of activity has on the type of discourse engaged in, an odds ratio must be calculated. The odds ratio explains how likely a student is to engage in a type of discourse given the type of activity (see Table 13).

Table 13

Odds Ratio Table for Type of Musical Discourse and Type of Design Activity

		Goal-Oriented Design (Activities 1 & 3)	Open-Ended Design (Activities 2 & 4)
Odds of engaging in…	Low-Level Structure	1.167	0.328
	High-Level Structure	0.857	3.046

The odds ratio is computed by dividing, for example, the number of times students used low-level structure responses during goal oriented activities and dividing by the high-level structure responses made. When the odds-ratio is investigated further, it is noted that students will engage in low-level structure responses 1.167 times during goal-oriented design activities. This number is just over one which indicates that the more goal-oriented design activities are used, the more low-level structure responses will increase. Similarly, it is observed that during

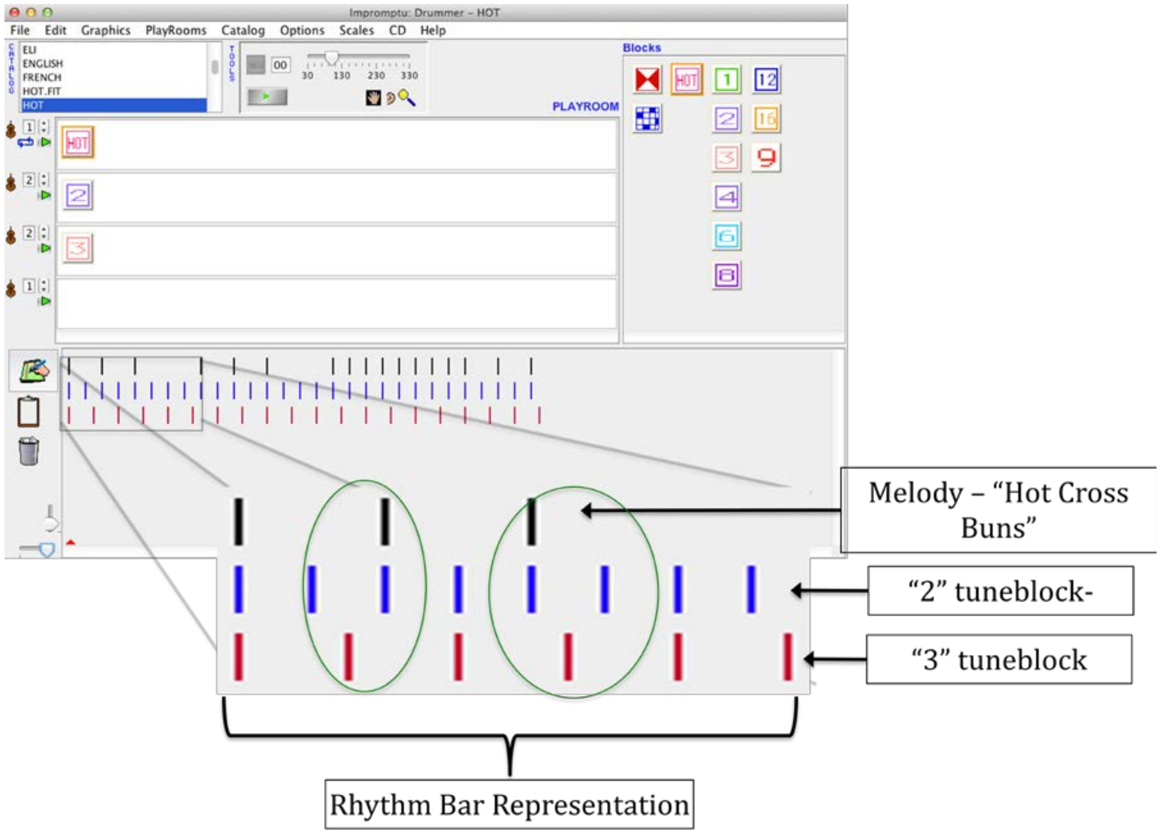
[8] SPSS only produces the p value of the McNemar test.

open-ended design activities, the odds are just over three times likely that students will engage in high-level structure responses. Conversely, odds ratios that are below one indicate that the more a student engages in a type of design activity, odds decrease that they will engage in a specific type of discourse. For example, odds are that the more students engage in open-ended activities, their chances of engaging in low-level structure activities decrease (Field, 2009). Implications will be discussed at the end of the chapter.

To provide further support, two excerpts from different activities (e.g., goal-oriented vs. open-ended) are provided. The first excerpt is from the goal-oriented Building Meter activity (day 10). For this excerpt (see Table 14) students were building a beat to the tune Hot Cross Buns, which is in duple meter (multiple of two). Students first heard the melody and were then asked what numbered blocks should be placed in the playroom in order to build the beat.

The first three quarters of this conversation consist mostly of the students expressing a like or dislike for what they are hearing (high-level structure responses) and offering random solutions to the problem. The practitioner, without explicitly telling the students there is a specific answer to the problem, employs a few different strategies to get the students to focus. The first is to walk to the rhythm of what is currently on the screen (see Figure 15).

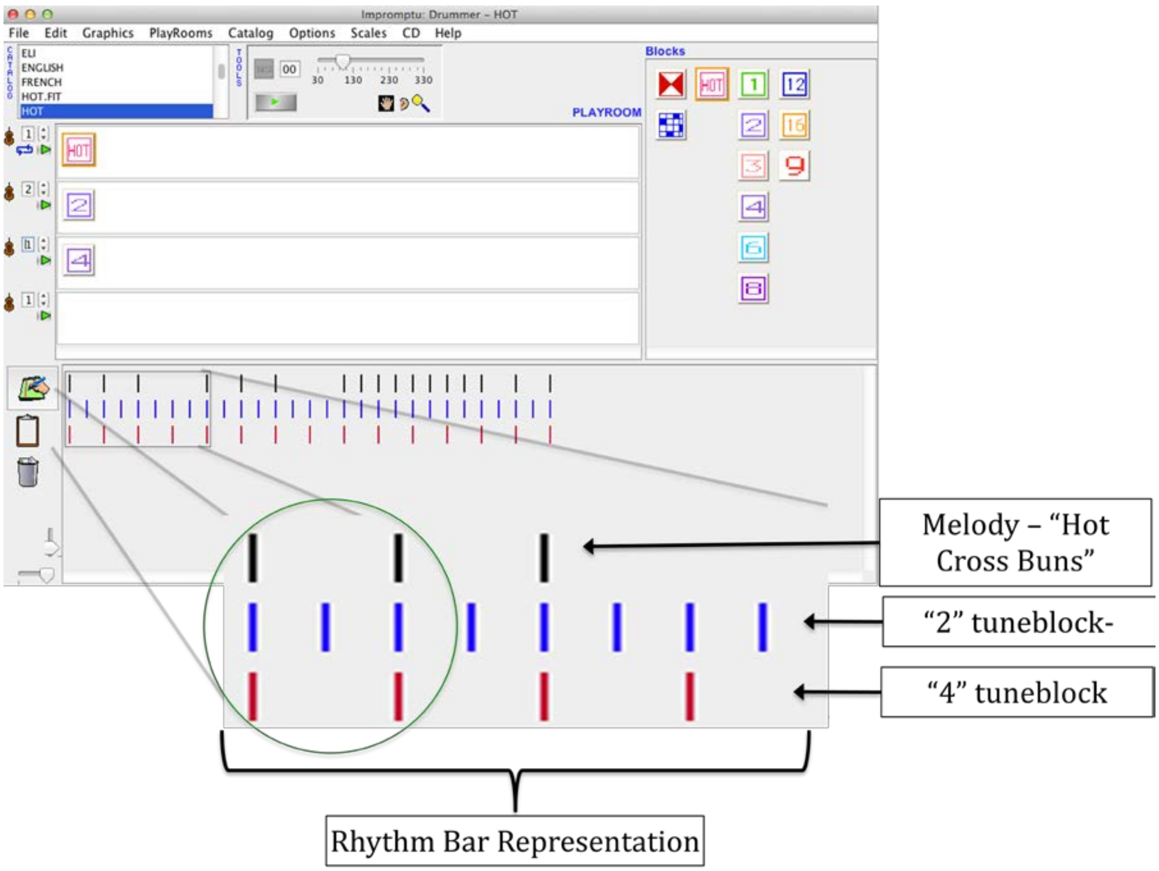
Figure 15. Impromptu Screenshot with Labels of "Hot Cross Buns" with "2" and "3" Tuneblock Magnified



The two rhythms do not match up. This is because the "2" block is a duple meter block and the "3" block is triple meter. This did not seem to encourage any conversations beyond evaluative responses (high-level structure) about what was heard.

To move the discourse along, the practitioner suggests keeping the "2" block and replacing the "3" block with the "4" block. The practitioner also explained that the goal was not to find one beat (or block) that would work, but a combination of blocks, much like the drums heard in popular music today. After playing the combination of the "2" and "4" block (see Figure 16), students were more vocal on whether or not it sounded right.

Figure 16. Impromptu screenshot with labels of “Hot Cross Buns” with “2” and “4” Tuneblock Magnified



The “2” and “4” blocks match up perfectly with the melody. It is still unclear that the students are grasping the pattern. To expedite this more efficiently, the practitioner walks to the rear of the class as if to get a whole picture look to what is going on in the music. Table 14 begins at line 36 with the practitioner offering the idea that there may be a pattern developing.

Table 14

Transcription of Practitioner and Student Interaction During "Building Meter" Activity with Interpretation

Line	Name	Transcription	Interpretation
36	Practitioner	I think we have something here. Now I want a slower on top of all this. So what should we try now?	The practitioner tries to move the discourse along to help student recognize the hierarchical pattern that exists in the beats. Graham gives both a mid- and low-level structure response when talks about the division of beats and the metric value associated. Both Graham and Gabe use the term "middle" to intuitively explain their hearing.
37	Class	Shouting out random numbers (5, 16)	
38	Practitioner	But you know (walks to back of room), just with those 2 numbers, I…I think I see a pattern?	
39	Class	(looks at the board) "Ohh" "Yeah, 2+2 is 4" "Oh, I know what it is"	
40	Graham	I see a pattern in there because the two's get like the middle one..kinda like that. And the fours get the other one. Kinda spread out like (inaudible)	
41	Gabe	Yeah, yeah. Cause like one blue one in the middle of an orange one.	
42	Practitioner	Well, wait a minute. We need to figure this out. So, that's very interesting. So if I play—so you guys can't see (plays the 2 block). Now, I'm going to play this next one…(plays the 4 block). Between those two, which one is going to get finished first?	Practitioner wants students to hear how beats can be divided up even though it seems some beats are going "faster" than others. Graham's initial explanation is within the mid-level because it talks about the tempo and the division of the beats. As he talks through it, he comes to the conclusion that the two blocks will end at the same time.
43	Class	Two	
44	Practitioner	Ok, people are saying two. Why?	
45	Graham	Cause it's faster	
46	Practitioner	It's faster?	
47	Graham	Well..they go at the same beat and they end at the same…(stops)	
48	Practitioner	Go ahead, they go at the same beat and	

		they…what?	
49	Graham	And they end at the same time…	
50	Practitioner	How is that poss(ible)…	There is incongruence between what Gabe thinks "faster" means and its relationship to the music in this context. Through his explanation he he has an "ah-ha" moment.
51	Graham	They don't exactly end at the same time…but the song's the same length and both of those meet at the end…ahhh	

Walking to the back of the room and mentioning a possible pattern grabs the attention of the class (line 39). Graham then explains that the "2" and "4" block are proportional to each other (e.g., "the two's get like the middle one" – line 40). To help Graham and the others recognize a proportion exists, the practitioner plays the "2" block separately from the "4" block and asks which one will get done first (line 42). The practitioner knows that because the "2" block is faster than the "4" block, the students will say the "2" block will get done first (line 43 – 45). Intuitively, faster means quicker, which means it should get done first. Within music, however, these beats are divided up proportionately. The practitioner asks Graham to elaborate further.

Interestingly enough, as Graham begins to talk (line 47) he stops himself in the middle of his thinking. This is a prime example of observing what the student knows (intuitively) and the knowledge they are constructing and the interaction of working with the materials (e.g., tuneblocks) and verbally expressing their thoughts. The practitioner encourages Graham to continue with this line of thinking (line 48). When Graham finishes his explanation, the practitioner asks how it can be possible that both will end at the same time if one is going faster (line 50). Graham quickly continues and reaffirms his earlier thinking and after his second explanation lets off an affirmative "ahh" (line 51) as if to say "I get it now".

For this goal-oriented activity, students are concerned with the problem at hand—finding the beat that fits the tune. This is not a negative, as it is clear that initially students stay within the mid-level structure, but through their interaction with Impromptu, each other, and the practitioner, they move to both the higher levels and low-level structures. The higher-level structures are observed when students are trying out different numbered rhythmic tuneblocks and are reacting to them. They are thinking about how those rhythms impact the overall structure of the tune. Also, moving to the low-level structures is observed when students explain the metric values (e.g., hierarchy) of the rhythm that is being constructed.

While movement to more sophisticated discourse was observed in this example, it takes time for students to become engaged using the discourse. This is because the nature of this activity, as well as the Reconstruction activity, is to solve a specific problem (e.g., put a song together). There is either a right or wrong solution and little room for thinking beyond this end goal.

When students engage in open-ended activities, the students seem to use and trust their intuitions more so than during goal-oriented activities. To show this, a brief excerpt from the "Construction" activity (day 5) is presented. For this activity, students were composing a tune using tuneblocks that were melodically tonal (e.g., a tonal center) and rhythmically balanced (e.g., duple meter). This was the second day into the activity and, up until this point, the class had decided on a suitable beginning for their tune consisting of four tuneblocks. Approximately eight minutes into the activity, a student suggested using the red block. The practitioner puts the red block in place, plays the composition, and a visceral, negative reaction is observed from the class. Table 15 shows the exchange after the blocks are played. Note how Eryn starts off at a high-level structure, and then moves to a low-level, then back to a mid-level within a very short time span. Overall, she is trying to convey that the red tuneblock does not fit with what has already been constructed.

Table 15

Transcription of Practitioner and Student Interaction During "Construction" Activity with Interpretation.

Line	Who is Speaking	Transcription	Interpretation
1	Eryn	It sounds like a ballerina dance.	High-level structure response talking about the style of what was heard
2	Practitioner	Tell me why it sounds like a ballerina dance…	
3	Eryn	Because it goes "duh-nuh-na-na". And it doesn't go with the right beat in the tune of how we have the first four blocks.	The focus is on the pitch (low-level) and the rhythmic and melodic contour of the piece (mid-level)
4	Practitioner	Can you explain a little further or can somebody help her explain a little further what she means…that it doesn't follow the beat?	The problem she is explaining is that what is heard now does not melodically or rhythmically match what is already constructed.
5	Eryn	It's not following the beat because, like we already have the beat except when the red block goes, it goes "duh-duh-duh-duh-duh-duh-duh-duh-duh-duh-duh". It has that different sound from the rest of them.	

As mentioned, the class started out with a set of blocks that were available to use to compose the tune. This is the mid-level structure (e.g., figures, phrases). When the red tuneblock is placed in the already constructed tune, it draws an immediate reaction from students. Eryn's initial explanation (line 1) is simultaneously working with what she intuitively knows (e.g., the red tuneblock did not fit with the other blocks already in place) and how to express, and thus, construct the knowledge needed to make sense of what is happening. Her solution is to provide a high-level structured and metaphorical description based on some experience she has had with watching (and hearing) a ballerina dance.

Seeking clarification, the practitioner asks a follow up question (line 2) that elicits a response in which Eryn is able to build off her initial description. She does so by first humming the block she heard—a low-level response—and then using that to move to the mid-level structure by explaining the red tuneblock does not fit with what has been built so far (line 3). The practitioner looks to get other students involved in the conversation by asking if anyone can clarify Eryn's explanation (line 4). However, Eryn is quick to continue with her reasoning by reaffirming her stance that the tune that has been constructed so far already has a flow to it and the red tuneblock is disturbing that flow (line 5).

Within this short amount of time, Eryn has moved up and down the structural musical ladder. While she has not been taught any of the musical terms she uses (e.g., beat, tune), they serve a purpose for her. Her experience with the words she uses, no matter how formal or informal, start out as nothing more than intuitive descriptors (e.g., "ballerina dance" – line 1) but then move to more specific descriptions ("beats" – line 3) and/or demonstration ("duh-na-na-na" – line3) of how she is making sense of the music. This is important because it shows that when activity and speech are coupled (i.e., reflection-in-action), intuitions work in not only strengthening what is already known, but also help construct new ways of explaining our understanding.

Limitations of the Current Study

There were limitations to the present study. The inability to randomize students to separate groups due to low participant numbers (N=36) as well as conducting the research in the context of a classroom during "instructional time" poses several threats to internal and external validity.

However, incorporating inter-rater reliability analysis for qualitative codes generated for analysis helps curb these threats. Further studies should incorporate, where appropriate, different groupings of students and use control groups to be able to better analyze quantitative data.

The comparisons between reflection-in-action and reflection-on-action conditions were not equal. More specifically, students were not required to either talk / participate in whole-class activities (reflection-in-action) or write in their journals (reflection-on-action) if they did not want to. This meant that some students who talked in class did not write in their journals and vice versa. Therefore, the design of the study may not be the most useful to compare these conditions. However, further research should incorporate design features in which the teacher makes a conscious effort to include everyone in the conversation. While this may be difficult from a logistics point of view (e.g., large number of students in the classroom), students could be broken up into smaller groups, which may encourage more engagement.

To that end, the use of multiple domains (e.g., art, music, math, science, language arts) could be used to peak student interest and engagement. The activity in this study focused only on music making. Future studies should incorporate many activities that correspond to the domain. As an example, some students could work on composing a tune, while others could focus on recording, producing, and/or editing the music, and even others could promote the artist (e.g., making fliers, posters, advertising campaigns).

The age group used in this study is also a limitation. As mentioned, students in this study were not fond of writing and this could have severely impacted the engagement of the students. Future studies should incorporate other modes of being able to reflect when students work alone. This could be giving the students a voice recorder or incorporating computer software that allows students to talk about what they are doing. Using different representations of reflection-on-action will help further explore the impact of different types of reflection in different curricular designs (e.g., group work vs. individual work).

Finally, generalizing findings to a larger population is a limitation. While the claims may not be able to be generalized to a wider population, there can be claims made about the processes of learning that take place during the activities in this curriculum. Obviously, more research is needed that can address the low participant/randomization of participants and integrating pre- and post-intervention evaluations (e.g., music learning assessments). This would help strengthen the overall claims made.

Discussion

The overarching theme to this chapter was the impact of designing a learning situation that emphasized reflection-in-action and how this metacognitive process of reflection and the underlying influence of intuitions encourage learning and engagement within a domain. The goal was to examine specific design choices within a constructionist learning environment that would encourage students to reflect and thus engage in sophisticated discourse within the domain. The connection to reflecting-in-action suggests that even younger students, who are not professionals or experts in a domain (e.g., music), can use their intuitions to reflect on what it is they are doing, similar in ways to what professionals do. This also suggests that the reflection (e.g., the talk) needs to be closely tied to what the student is doing in the moment so that the reflection becomes more meaningful and promotes further construction of knowledge beyond, for example, mid-level structures (e.g., what they already know).

However, the larger take-away message is that the intuitions a student has about a domain can be powerful guides in the construction and use of new knowledge. Younger students, who are not professionals or experts, can begin to do and think as a professional would if they are given the opportunity to do so. They can use and trust their intuitions to serve them in a positive way. As was observed, reflection-in-action promotes more music-related responses than did reflection-on-action.

Intuitions, both their impact on learning and how to encourage their use despite their correctness, is largely overlooked in education research. This is because intuitions are not formalized knowledge structures that can be easily measured (diSessa, 1993; Fischbein, 1987). Intuitions help us in seeing the whole of a problem and fill in gaps in our experiences to give us a complete picture of how things work in the world (Bruner, 1977; diSessa, 1993; Fischbein, 1982; Noddings & Shore, 1984). Literature in the Learning Sciences and elsewhere tends to treat intuitions as a 'catch-all' phrase that lacks a clear operational definition (c.f., Clement, 1993; Dori & Belcher, 2005; Resnick & Wilenski, 1998; Zietsman & Clement, 1997) and seems to encompass what people know, yet do not know how they have come to know (Noddings & Shore, 1984). Intuitions are extremely useful in understanding both learning and teaching within specific domains (e.g., music) (Bamberger, 2013; diSessa, 1993; Schön, 1983; 1987). The findings presented in this chapter highlight that even without prior knowledge of a domain (e.g., music) intuitions help guide thinking during the construction of a meaningful artifact.

One commonality in the intuition literature is that if intuitions are ignored, it could be detrimental to learning later on in life (Bamberger & diSessa, 2003; diSessa, 1993; Fischbein, 1987; Laevers, 1998; Smith, diSessa, & Roschell, 1994). diSessa (1993) sums up this negative effect:

> Perhaps the most devastating implication of ignoring the sense of mechanism…is building an unwarranted wall between prior knowledge and scientific understanding may

> alienate students. I am convinced that one of the most problematic parts of current instruction is that students do not feel that they can really participate (p. 205).

What is being suggested is that when intuitions (e.g., sense of mechanism) are ignored, the learner may develop a dependence on prior knowledge when intuitions may be more useful. However, and most importantly, is that the learner will also not participate in activities because they feel their prior knowledge is not adequate. The pedagogical framework and results of implementing this framework discussed in this chapter have addressed this concern.

Students in this study were encouraged to explain their thinking and decision making process. The practitioner gave ample amounts of time for students to do this and encouraged deeper thinking by asking follow-up questions throughout. Since the students in this study had little to no prior knowledge of music (e.g., formal music lessons), their dependence on prior knowledge was not an issue. Therefore the "wall" between what a student already knows and their understanding is not being constructed. Instead, the student's intuition is being used in productive ways in which they can decide whether or not the intuition is a viable mechanism to be used.

The impact on music teaching and learning

Creative activities like music composition provide learners with the experience of doing what an expert does, or as Resnick and Wilensky (1998) state, it gives the student opportunities to "dive in" (p. 155) or play the role of a music composer. This "diving in" allows learners to make use of what they know how to do already. Music composition and intuitions are relatively understudied in areas of educational research like the Learning Sciences and this study provides a way in which to investigate them.

Parsing the activities out further into specific types of activities opens up new possibilities and questions to be asked. Based on the data presented in this chapter, it is suggested that both goal-oriented and open-ended design activities are beneficial in encouraging sophisticated musical discourse. It is possible that the concepts that emerge during the activity guide how the student talks about her composition. As an example, during the goal-oriented "Building Meter" activity, concepts like intervals and sub-division of beats becomes important. The student's discourse gravitates towards this low-level structure in order to make sense of what is happening. The same could be said for open-ended activities in that the student evaluates the style, genre, or instrumentation of her composition based on cultural norms (e.g., what she already knows) and therefore, high-level structure responses are used more frequently. This opens up more questions for investigation including how to integrate goal-oriented tasks in open-ended activities and vice versa and observing the types of discourse that emerge.

There is utility for both goal-oriented and open-ended activities as students do engage in both high- and low-level structure discourse in these activities. These types of structures are important because they are the concepts that have not been formally taught to the students but are valued by the music education community (c.f., NAfME, 2013). This would suggest that practitioners who wish to encourage a deeper engagement and learning within the domain via musical related discourse should engage students in activities that are creative and open-ended. That is, students should be in charge of what it is they are creating; they take on the role of a professional (e.g., composer). Through this type of engagement, they encounter problems, mistakes, and surprises that force them to reflect both in- and on-action using their intuitions to guide both the design process (e.g., composing a tune) and the knowledge construction process. This type of reflection is essential for learning in a constructionist environment (Papert, 1991).

Overall, pedagogical practices that give students the opportunity to talk while they engage in a constructionist activity that is creative and open-ended promotes a use of discourse that was once thought to be beyond a novice's level of engagement. More generally, a student with no formal training (e.g., a novice) who engages in a creative design activity (e.g., open-ended music composition), which in turn encourages reflection-in-action, will begin talk about the domain that demonstrates a grasp of concepts not formally taught. That is, the intuitions the students have about the domain become more relevant and useful in order to engage with the activity. When the student talks about their intuitions, they are able to judge the intuitions usefulness based on, in this case, what they say about their composition and what they hear in their composition.

The impact of these findings is paramount to both pedagogy and to learning. As noted, pedagogical practices should consider activities that emphasize both goal-oriented and open-ended projects that encourage students to talk about their creations as they are being designed. When this happens, students engage in a discourse that reflects a sophistication that was thought to be beyond their capabilities. Overall, this research can solidify the idea that intuitions should not just be used as a 'catch-all' phrase to explain what cannot be explained and that intuitions provide key foundations to critical thinking and problem solving if there is a clear foundation given for intuitions and how it relates to the researchers theoretical framework. This research can also inform teachers about what intuitions are, how to recognize them, and what sorts of strategies can be used (e.g. questioning) in order to foster intuition development and use (van Zee & Minstrell, 1997). Finally, allowing students to use their intuitions when solving problems provides policy makers a chance to look at how activities that encourage intuitions can be implemented in a wide range of topics and age ranges.

CHAPTER FOUR

The Aesthetics, Creativity, and Craftsmanship of Fourth-Graders' Compositions

Abstract

An intuitive approach to music composition within a computer-aided environment provides the learner the opportunity to engage with music without having a formal knowledge of the structures of music or how to perform on an instrument. This is not to say these issues are not important. To the contrary, this intuitive approach to composing music can help shed light on what the learner is paying attention to when they are composing a tune. What is not known is how to best evaluate these compositions in a way that does not hinder creativity in lieu of looking for formal concepts or processes. The research conducted in this chapter is guided by the following question: Based on standard assessments of music composition, do student compositions reflect a greater sense of aesthetic appeal, creativity, and craftsmanship at specific time points? Two fourth-grade classrooms (N=36) engaged in a music learning and composition curriculum using the computer tool Impromptu. As part of the curriculum, students first engaged in a whole-class activity where the practitioner would facilitate the music composition process while engaging learners in conversations about what they were making. Students would then do similar activities on their own. Student compositions were collected at the end of each individual activity and used as the main focus of analysis. Analysis of the compositions used Hickey's (1998) general assessment rubric for music composition that specifically targets the composition's creativity, craftsmanship, and aesthetic appeal. Compositions were evaluated on a scale of 1 to 4 (1 meaning "Needs Work" and 4 meaning "Terrific!") and a repeated measure ANOVA was used to measure changes at the beginning, middle, and end of the study. Findings indicate that students do not simply tinker with their composition but pay attention to how their

song is put together over time, which is a trait seen in professional composers as well. Implications of these findings promote the idea that general approaches to evaluating music may help inform further pedagogical approaches to music learning based on what and how the student composes.

Introduction

What does it mean to learn music? Is it being able to play an instrument? Is it being able to compose a piece for an instrument? Is it the ability to listen and analyze the style and genre of a particular piece of music? Or is it a combination of these? In the last 20 years, the role of technology has changed how people engage with music, specifically those learners with little to no formal training or knowledge of music (e.g., reading/writing music notation or performance) (Bamberger, 2003; Green, 2002; Savage, 2005; Väkevä, 2010). This is because our experiences with music—what we intuitively know about music—are vast and guide our understanding of how music functions (Bamberger, 2013; Swanwick, 1994).

The role of technology in music learning is still a highly debated topic, especially as it relates to how the technology is being integrated, what is being learned, and how to evaluate that learning (Savage, 2005; Webster, 2006). More specifically, technology affords the user the opportunity to create a piece of music without being proficient on a musical instrument or having the formal knowledge needed in order to create, for example, a jazz chord progression. Embedded in this debate is the idea of creativity and whether or not creativity is enhanced or diminished because of technology. Creativity is important because it spawns innovation, impacts problem solving, and is a vital skill to have in the 21st century (Partnership for 21st Skills, 2009; Sternberg & Lubard, 1999). What is not known is whether an intuitive approach to music composition using a computer impacts creativity over time and what, exactly, are students paying attention to when they create a piece of music. While there have been studies on the (micro) development of younger students' compositions over time (c.f., Kratus, 1989), the approach in this chapter evaluates compositions over the course of weeks rather than one point in time. Also, the compositions were scored using a general assessment of music composition rather than an assessment that focuses on specific concepts, ideas, or processes. The reason for this is because the nature of the activities was intuitive. That is, the students did not have a formal, nuanced knowledge of music. Using a general assessment can help inform the dimensions of creativity (i.e., creativity, craftsmanship, and aesthetic appeal) that students focus on while composing a tune.

The research presented in this paper is guided by the question: Based on a general assessment of music composition, do student compositions reflect a greater sense of aesthetic appeal, craftsmanship, and creativity over time? To answer this question, a music-learning curriculum (Bamberger, 2000), modified for younger learners, that is grounded in a constructionist learning framework (c.f., Bers, 2008; Kafai, 2006; Peppler & Kafai, 2007; Papert, 1980), was utilized. Students composed tunes using the computer software Impromptu (freely available at www.tuneblocks.com). These compositions were collected and analyzed using a rubric that specifically targets the aesthetic appeal, craftsmanship, and creativity of a composition (Hickey, 1998).

The approach taken in the chapter is unique in two ways. The first is making explicit the connections between constructionism, the use of intuitions, and creativity. While the connection between constructionism and creativity has been discussed before (c.f., Kafai, Peppler, & Chapman, 2009; Peppler & Solomou, 2011) and especially within the areas of media and game production and literacy (Kafai, 1994; Kafai & Peppler 2011; Peppler & Kafai, 2007), very little is known about how creativity relates to intuitions, particularly in the context of learning. Second is the interplay between the development of musical knowledge and the use of technology. Webster (2006), in his extensive review of technology's role in music learning, asserts that little is known about the true impact of technology in music learning because (1) we do not know how technology is being integrated, (2) we do not know how much music teachers know about the technology, and (3) there seems to be no philosophical consensus on why and how technology should be used in music learning. Crow (2006) agrees that teachers need to rethink, and thus redesign, curriculums to include not only technology, but to recognize the creativity that goes into making music with technology. However, there is little agreement on what is creative (Hickey, 1998), whether or not creativity can be "taught" (Brinkman, 2010), and how to teach creativity (e.g., improvisation) (Brophy, 2001).

Background of the Study

The examinations and findings reported in this dissertation advance the possibility of a new pedagogical framework that encourages students to express their intuitions while engaged in making something (e.g., a music composition). As reported in the previous chapters, this pedagogical framework can be accomplished through (1) the practitioner's active role in engaging the students through simple inquiry (e.g., asking "why" questions) and (2) giving students an opportunity to verbally express their intuitions. The third component to the pedagogical framework is investigating the artifacts being produced and more specifically the dimension of creativity the artifact reflects. The purpose of this chapter is to investigate what dimensions of creativity—creativity, craftsmanship, aesthetic appeal—students focus on when composing a piece of music using the computer software Impromptu.

Creativity

Creativity has been the subject of debate as early as the late 1960's when Torrance released the Torrance Test of Creative Thinking (TTCT) (Torrance, 1962). This test has been widely used, re-evaluated, and criticized throughout the years. Through its many iterations, the

TTCT elaborates on specific scales[9] that help define creativity. First, fluency involves looking at the number of ideas related to the problem at hand. Second, originality, looks at the number of new, uncommon, or unique responses to a problem. Third is elaboration and refers to the ways in which people develop their ideas. Fourth, and the first of a recent addition to the scale, is abstractness of titles and investigates the person's ability to think abstractly about a problem. The final scale and the second of a new addition is resistance to premature closure which posits that the creative thinker must be open to new ideas and ways of thinking. The criticism with the TTCT, and most measures of creativity, is whether these scales are applicable in all domains (Amabile, 1982).

The larger issue is what exactly is creativity? For any domain, it is important that creativity be well defined (Plucker, Beghetto, & Dow, 2004). And while there are many researchers with differing definitions of creativity in music, for the purposes of this research, Webster's (2002) definition is most fitting. He suggests that creativity in music is "the engagement of the mind in the active, structured process of thinking in sound for the purpose of producing some product that is new for the creator" (p. 26). There are two important phrases to take out of his definition. The first is "thinking in sound". This suggests that the person engaged in a musical activity must be able to manipulate and play with sounds. The second is "producing some product". This promotes the idea that the person must make something (e.g., a composition) they find meaningful.

Issues still remain when dealing with creativity, more specifically, how to measure creativity and what to measure. Plucker, Beghetto, and Dow (2004) suggest that research methods in creativity provide excellent frameworks with which to view learning and

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[9] Flexibility was originally included in the five-part scale. It was removed because it correlated very highly with fluency (Hébert, Cramond, Neumeister, Millar, & Silvian, 2002).

understanding within a domain. Specifically, they point to (1) Czikszentmihalyi (1988) and his systems view that emphasizes an individual working in a domain with culturally defined norms and practices and a peer group to evaluate the outcome as creative; and (2) Amabile's (1982) view that social psychological components are key to understanding the creative thought process. The intent of the investigation presented in this chapter is not to unveil a new or altered view of creativity but to present a pedagogical approach that allowed students to "think in sound" and produce a product they found meaningful (Webster, 2002).

The larger issue is how to measure what is creative. The pedagogical approach taken in this dissertation emphasizes the expression of intuitions while making an artifact (e.g., reflection-in-action). Briefly, intuitions are small knowledge structures that are activated through experiential means (diSessa, 1993). When these intuitions can be expressed during an activity (e.g., listening and/or composing a tune) they become more useful when engaging with or solving a problem. Central to this argument is using the computer as a tool so that students can focus on what they think is important in their designs (i.e., compositions) rather than some specific definition brought about by experts in the domain (e.g., composers). What impact does this have on the creativity, aesthetic appeal, and craftsmanship of the artifact being created (e.g., music composition)?

Amabile (1982; 1983) suggests that judges need to be familiar with the domain but must use their own subjective view of what is creative rather than some standard within the domain and use dimensions of aesthetic appeal and craftsmanship. This is done to alleviate the possibilities that judges are evaluating the creativity of an artifact on, for example, the aesthetic appeal. For example, a judge may determine that a composition is pleasing to their ear and it holds their attention. While this may be perfectly reasonable, there may be other dimensions the judge is not focusing on, such as the craftsmanship used to organize the piece of music.

Evaluating the Artifact: Creativity as a Means of Learning

Students' compositions in this study were evaluated using a general music composition rubric designed to assess the overall creativity of a composition. Hickey uses Amabile's (1982; 1983) consensual assessment technique (CAT) as a framework. The CAT calls for an expert (i.e., composer) to rate an artifact (e.g., music composition) using their subjective definition of creativity. Unfortunately, who is an expert in relation to judging a music composition? A composer? Music teacher? This was an issue Hickey set out to examine when determining what is creative to these experts. It was found that general music education teachers had the most agreement about creativity, while composers had the lowest agreement when judging students' creativity in their music compositions (Hickey, 2001). To combat with issues related to the judge simply liking a piece for its technical components and/or aesthetics, Amabile (1983) suggests including both craftsmanship and aesthetic appeal as assessments of creativity.

The wording for this rubric was developed using common themes and attributes that emerged from judges scoring the musical compositions (Hickey, 1998). Specific to creativity, the music composition should include imaginative, original, and/or unusual musical ideas and explore two musical elements at the very least (Hickey, 1998).

The dimension of aesthetic appeal relates to the idea that the product that has been produced has some pleasing features (Amabile, 1983; Hickey, 1998). With regards to music, this can be thought of in terms of, for example, consonance and dissonance in Western musical traditions. More specifically, consonance refers to notes or grouping of notes (e.g., chords or melodies) that when played are stable sounding or pleasing to the ear. For example, a C-Major chord contains the notes C-E-G and when played together are pleasing to the ear. Dissonance refers to notes or harmonies that are not stable when played together. As an example, if you played a C and C-sharp together, the resulting sounds would not be pleasing.   This does not mean the artifact (e.g., tune) is not creative and what is creative may reside in the artifacts craftsmanship.

Craftsmanship, or as it is sometimes referred to, technical goodness, is “the degree of technical competence displayed by the subjects in their work…composed of neatness, planning and expression of meaning.” (Amabile, 1983, p. 107). This means that the artifact has been planned out and crafted (e.g., assembled) in a way that reflects an organizational pattern (e.g., beginning, middle, and end) to the piece. As an example, the tune “Mary Had a Little Lamb” has a clear beginning, middle, and end both rhythmically and melodically. Conversely, the genre of free jazz may not audibly reflect a well thought out or obvious organizational pattern with its odd rhythmic groupings, use of chords that do not resolve (e.g., do not sound like they end), and uncommon harmonies and instrumentations.

Like aesthetic appeal above, craftsmanship is just another dimension of creativity that should be taken into account when evaluating what is and is not creative. Amabile (1982; 1983) argues that what is considered creative be based on the judge’s subjective definition and be measured not only using the subjective criteria but also the measures of aesthetic appeal and craftsmanship. The compositions in this study were scored using Hickey’s (1998) general music composition assessment rubric that was developed using the CAT.

The Importance of Computer Music Composition

Problems in learning music, especially in younger learners, are evident when looking at the National Assessment of Educational Progress in the Arts (NAEP) (U.S. Department of

Education, 2008). Students in eighth grade averaged a scored 150 out of 300 on assessments of music that included concepts related to describing and identifying musical moods, elements, cultures, and instruments. While the 2008 assessment included a question that required students to complete a short rhythmic pattern using rhythmic notation, these findings were not reported. It is clear that both time and money are being cut from most arts-related programs in schools today and that clearly is an issue. The NAEP also surveyed eighth-grade students on the activities they engage in during class. Listening to music was most the prevalent activity and making music was the least engaged activity. The research has shown, however, that children, including very young children, readily make up songs using everything from their voices and bodies, objects in their environment, and computers (e.g., sticks, pots and pans) (Bamberger, 1996; Campbell, 1998; Upitis, 1990).

Giving young learners the opportunity to create their own music gives teachers and researchers a more clear insight into the sense making of the learner (Kaschub & Smith, 2009; Swainwick & Tillman, 1986). Music composition, while arguably a creative and aesthetic activity, is also an ongoing and evolving problem-solving activity (Kaschub & Smith, 2009). The composer is constantly solving new and interesting problems that evolve in the composition process both during and after the composition has been constructed (e.g., melodies, harmonies, counterpoint, tempo, dynamics).

Burnard (2007) suggests that the use of technology in music learning and teaching will bring about pedagogic change in which teachers and students work together in creating an artifact (e.g., composition) that is meaningful. But what impact, if any, does using technology have on creativity? Seddon and O’Neil (2003) investigated the creative thinking processes of two groups of adolescent students who either had formal musical instrument training or did not.

Each group engaged in a computer-based composition activity for one week. Qualitative differences between the groups reflected three meta-approaches to composition: Crafting, Expressing, and Immersing. Briefly, Crafting reflects deep planning and construction of a composition. Expressing highlights the composer's exploration and rehearsal of their composition. Immersing deals specifically with exploration. They found a significant association between the training conditions and the amount of exploration the composers used. More specifically, those with no formal musical instrument training did more exploring. These meta-approaches are somewhat similar to the dimensions of creativity used in this study.

Nilsson and Folkstead (2005) reported on eight-year olds composing music using a synthesizer and computer sequencing program. They qualitatively observed that these younger learners, with no formal musical training, composed music that ranged from the very simplistic to complex and incorporated musical concepts including form, structure, repetition, and rhythmic and melodic development.

Conversely, Kuehne, Lundstrom, and Walls (2013) investigated the differences between fourth-grade students who composed using paper/pencil and those who used a computer software program (i.e., Finale Notepad). Students were specifically taught certain concepts that were required for their composition (e.g., meter, melody, rhythm dynamics, ABA form). Students evaluated each other's compositions using the researcher designed rubric. Within the rubric, students were asked to rank the creativity of the whole piece through the use of melody, form, distinct rhythms, tone, and dynamics. It was observed that there were no significant differences between the paper/pencil group and the technology group.

The activities used in this research emphasized an intuitive approach to composing music. That is, the computer tool (Impromptu) was specifically designed to start the learners out at a mid-level structure; what they intuitively know (Bamberger, 1996). Students were encouraged to explore their musical ideas by “thinking in sound” and producing a composition that they found meaningful. They were also encouraged to talk and write about their compositions, which provides a powerful lens to view musical creativity and learning (Barrett, 1996). This constructionist approach allows learners to transform their knowledge about the domain (e.g., music) while making a tangible and shareable artifact (e.g., music composition) (Bers, 2008; Kafai, 2006; Peppler & Kafai, 2007).

Constructionism

Constructionism is the idea that learning happens when learners construct their knowledge, and this happens best when they are building (constructing) something that is personally meaningful to them (c.f. Papert, 1980; 1991; Kafai, 2006; Wiggins, 2009). The connections to Piaget’s constructivism are apparent. Papert agreed with Piaget that children were very skilled at constructing their knowledge, but felt Piaget did not emphasize the role of the tools that the surrounding culture provides, or does not provide, the learner (1980). More specifically, Papert (1980) noted that when cultures provide tools, the learner is able to make their abstract thinking more concrete.

However, there is more to this than just the surface level notion of learning by making things’. The implication of this statement is that when a learner is able to construct something, they are engaged in a process of reformulating their knowledge with the world and make new connections to knowledge. Because learners are constructing something, they are making their internal representations more external and more concrete (Bers, 2007; Kafai, 2006; Papert, 1980; 1993). This does not mean, however, that making something equates to learning. What it does mean is that the process of making is what is important.

More specifically, Papert (1980; 1991) suggested that there are two important concepts in constructionism; purpose and reflection. Learners need to have an intrinsic purpose for engaging in an activity as this creates tendencies to persist in the face of challenges (e.g., failure) (Papert, 1980; 1993). Reflection is the key to the knowledge construction process (Papert, 1991; Schön, 1983). Reflection, whether it is explicit (e.g, verbalized) or not, is a part of the creating process because when something is being created, the creator steps backs and looks (or listens) and then determines what changes, if any, need to be made. For Papert (1980; 1991), this is an under-utilized practice (e.g., talking about learning). So, in essence, constructionism is about making new connections to the world, by making the abstract more concrete, and by reflecting on knowledge—which happens best when learners are constructing things that are personally meaningful (Bers, 2007; Kafai, 2006; Papert, 1980; 1993).

The constructionist framework is a lens to investigate the creative output of the participants in this study. The use of music composition provides a unique look at the creative process as it happens—as discussed in the previous chapter—and the eventual artifact that is produced.

Methods

Overview

The research in this chapter is guided by the question: Based on a general assessment of music composition, do student compositions reflect a greater sense of aesthetic appeal, craftsmanship, and creativity over time? A rubric designed by Hickey (1998) that used Amabile's (1983) consensual assessment technique as a framework was used to evaluate student compositions at three different time points in the study. Appropriate statistical methods including repeated measure ANOVA's and post-hoc tests were used to detect differences over time. Issues with missing data are also addressed.

Settings and Participants

The research took place in a school located in a mid-sized, midwestern city. The school serves 253 students in grades K-8 with 92% of the population being of European American/Caucasian descent and the remaining 8% distributed amongst African American, Asian, Hispanic, and multi-ethnic. A total of 12% of the students received free or reduced lunch. The participants—referred to as students from this point forward—included the school's entire fourth-grade population (N = 36).   A convenience sampling method was used because the group of interest (e.g., fourth-graders) was already formed and there was a school-wide emphasis on Science, Technology, Engineering, and Mathematics (STEM) with a specific focus on technology in the classroom.

The 20-hour curriculum used for this study was a substitute for the two fourth-grade classrooms' STEM activities. Under normal circumstances, students would meet for approximately one hour per day, five days per week to engage in projects that utilized iPads and applications, including iMovie.[10] Both general education teachers and the STEM teacher agreed the curriculum proposed in this study was a more than suitable replacement.

The Tool: Impromptu

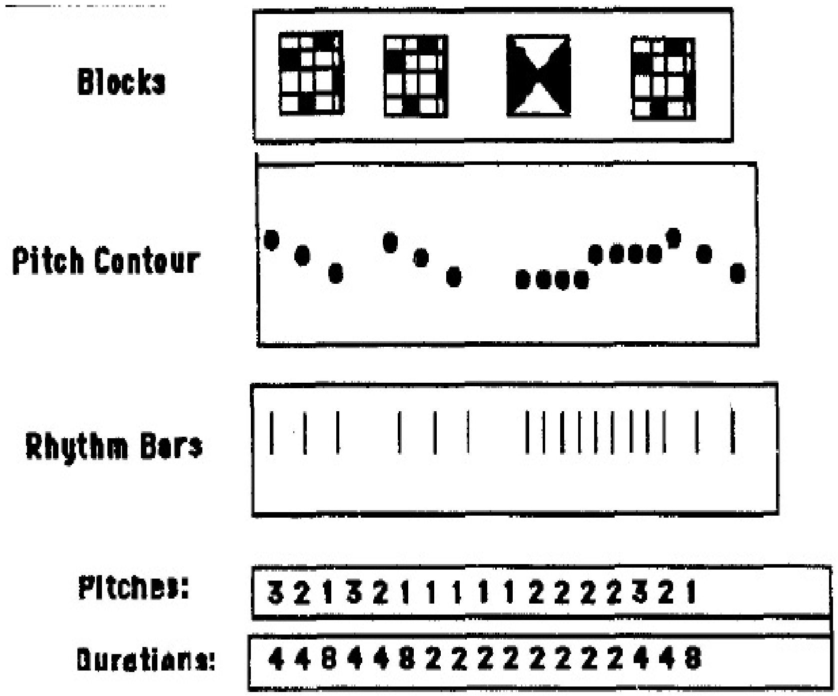
Impromptu (Bamberger, 2000) was designed to allow learners to address, act, and reflect on their intuitions by presenting musical phenomena situated within meaningful (virtual) blocks of music, called 'tuneblocks'. To navigate Impromptu (see Figure 2), users pick a tune from the menu; the tune is then represented and broken up into different virtual blocks. Users can then

[10] Students were originally going to be working in small groups and making short, how-to videos using iMovie related to different jobs in the school's cafeteria.

either put the blocks back in order to recreate the song, make a new song by rearranging the blocks, or edit the blocks themselves in order to make an entirely new composition. This allows learners to question their intuitions under the premise of "what happens if…?" This is important because it allows the learner to reformulate their knowledge of the domain and thus connect to powerful ideas about music (Papert, 1980).

As Bamberger (1996) posits, "Impromptu makes it possible for students to begin their music study at the mid-level of structure" (p. 44). The mid-level structure (e.g., tuneblock) she is describing refers to the meaningful structures that people already have about music, including phrases (larger sections or whole songs), figures (smaller phrases), and the functions of stability and instability in music. Starting at this mid-level allows learners to move freely to larger structures (e.g., whole songs) and to more detailed structures (e.g., notes and durations) (Bamberger, 1996). However, this mid-level structure is not the only way in which students can engage with Impromptu. There are several graphic representations that also give learners the opportunity to engage with the music at different levels (see Figure 17).

Figure 17. Graphic Representations in Impromptu (Bamberger, 1996, p. 49).



The tuneblock represents the mid-level structure that is important to engaging learners in what they already know. Musical concepts such as repetition—the number of times a section repeats—can be easily viewed by using the tuneblocks. The pitch contour representation highlights the pitch and time relationship between notes. The rhythm bars represent a space and time relationship of the tune or tuneblock. And finally, a more detailed approach would be to open the blocks using the magnifying glass icon in Impromptu and change the individual pitches and durations (see Figure 17 "Pitches" and "Durations" on what opening a tuneblock looks like). These representations, along with Impromptu's easy-to-navigate interface, allows learners of all experience levels to create music while at the same time allowing them to reflect and talk about their creations.

It is important to remember that Impromptu was not designed specifically as a compositional tool but as a learning tool that allows users to listen more intently to the tune they were working with. The end goal is not a finished piece of music (although, that could be a goal) but a way for users to challenge their assumptions, make sense of the music, and connect to new forms of musical knowledge (Bamberger, 1996; 2000). This is clearly a limitation especially when trying to fully "think in sound". For example, depending on the tune that is being worked with, the tuneblocks may already have a sense of melodic and rhythmic balance. And while this may be pleasing for listeners, they may find it difficult to navigate the software to make or alter a block. That is, the time utilized for "thinking in sound" may be taken up by navigating the Impromptu interface. Both limitations to the curriculum and the tool will be explained in the chapter.

The Curriculum

The study took place at the beginning of the school year, which means students were not fully engaged in any set music curriculum from their music teacher. I interviewed the music teacher to get ideas about the types of activities the students engage in or have engaged in during the previous year. She noted that since music was one to two times per week—depending on the time of year for test preparation— that students would normally be preparing for holiday programs and religious services. However, she did note that she introduces musical games that include rhythm, tempo, and simple note recognition (e.g., pitch and duration) and, if time permits, she allows them to play on the available instruments in the class (i.e., maracas, drums, xylophone, and piano).

Following IRB approval (study # 1112007636) and prior to implementing the curriculum, students were asked to compose a tune using Impromptu. One class period (1 hour) was dedicated to showing the students how to navigate[11] Impromptu's interface. Two class periods were then dedicated to letting the students compose their tune. Once this was completed, the implementation of the curriculum began.

Each day of the study was recorded in both audio and video formats. I adapted the curriculum for this project based on Bamberger's (2000) curriculum, which was originally intended for university students to suit the developmental needs of the students (i.e., fourth-graders) in this study. Briefly, this university curriculum consisted of investigating (1) the structure of music by focusing on reconstructing and composing tunes using predetermined tuneblocks, (2) the structure of rhythm by building rhythmic accompaniments to tunes, (3) the relationships between pitches by deriving melodies from existing tuneblocks and making new melodies, and (4) harmonies and chord structures (polyphony). Each component builds off each other, starting at a mid-level structure (e.g., reconstructing tunes) and gradually moving to a more detailed level (e.g., making melodies and harmonies).

Based on this, as well as pilot investigations (Downton, Peppler, & Bamberger, 2011), the adapted curriculum focused on four main activities: (1) Reconstruction, (2) Construction (3) Building Meter, and (4) Final Project. The first component of the curriculum, "Reconstruction", required the student listen to a familiar song (e.g., Hot Cross Buns) and then take the set of corresponding tuneblocks and put them in the order that made the original tune[12].

[11] This included general concepts like what the different parts of Impromptu (e.g., tuneblocks, playroom, etc.) were along with how to, for example, place tuneblocks in the playroom, change instruments, and change visual representation modes. More advanced issues (e.g., making and/or editing tuneblocks) were done later in the curriculum after the "Building Meter" activity and before the "Final" activity.

[12] Metaphorically, this can be thought of as taking a set of puzzle pieces and putting them together.

The second component of the curriculum, “Construction”, built upon the reconstructing activity by allowing users to work with tunes and tuneblocks that are melodically and rhythmically balanced (i.e., having melodic and rhythmic qualities familiar in Western music). This activity was much like the reconstructing tunes activity in that students used the tuneblocks provided to them. However, instead of simply putting the blocks in the correct order, they organized them in a way that made the most sense to them and thus created original music compositions in the process.

The third component of the curriculum, “Building Meter”, students selected a tune from the Impromptu library that has an established melody residing in a single tuneblock. The other blocks contain rhythmic patterns and students organized and built a beat (meter) for the tune by adding the rhythmic based tuneblocks. Working with these rhythmic blocks allowed learners to see and hear the hierarchical structure of the rhythmic patterns in music.

The fourth and final activity was a Final Composition project in which students were allowed to create a piece of music either from scratch or using a specific set of tuneblocks that I selected for the students. These particular tuneblocks were atonal (e.g., no central key signature) and rhythmically unbalanced. Students were encouraged to alter the tuneblocks or make new ones.

According to Bamberger (2000), it was important to follow these components in order because it began with introducing music at a meaningful and structurally relevant level, which gave learners a chance to build on their intuitive understanding as they moved through the projects. Additionally, during each activity, certain conceptual ideas that aligned with the scoring rubric were given a central focus. For example, during the Reconstruction and Building Meter activity, the concept of repetition, antecedent/consequence (e.g., question/answer, beginning/end) and tempo are highlighted. This aligns well with the craftsmanship and aesthetic appeal dimension. Similarly, concepts related to melody, pitch of notes, and analysis (e.g., evaluation) are presented during the Construction and Final Composition activity.

Finally, creativity was encouraged throughout the activities. Using a constructionist lens to frame this study, students were encouraged to explore all possibilities including instrumentation, tempo variation, and creating new or altering tuneblocks. This was accomplished by first giving students an intrinsic purpose for creating a composition. That is, they were allowed to create something they found meaningful. Second, they were encouraged to reflect by talking during whole-class activities and keeping notes in their journals during individual activities.

For each activity in the curriculum, students worked first in whole-class activities led by the practitioner.[13] Students then worked individually on the same activity, using different tunes than the ones used in the whole-class activity so as to not encourage them to repeat or recall what they had heard and/or done previously. Regardless of whether it was whole-class or individual work, students were given ample opportunities to "think in sound". This was accomplished by allowing students to tinker and play with different sounds within the Impromptu environment. The practitioner allowed students multiple days to work on their composition. And, students were given an environment in which new challenges and solutions may arise and where final ideas can be put into action.

[13] I was the practitioner for this study due to my experience engaging young students in music related activities and professional experience with technology and music. Also, both general education teachers and the STEM teacher felt their lack of knowledge in both music and the technology involved (Impromptu) would only hinder the goals of the project.

Data and Analysis

The data sources specific to this chapter were the students' individual compositions via the Impromptu computer file. All compositions were collected after each activity and stored on a secure external hard-drive. However, only the compositions done during the "Pre-Composition", "Construction", and "Final" activities were analyzed. This is because the "Reconstruction" and "Building Meter" activities were conceptually oriented and involved solving a specific problem (e.g., reconstructing a tune). Judging these tunes for creativity and aesthetic appeal was not possible as the activities did not involve these concepts.

The data was analyzed using Hickey's (1998) general assessment for music composition (see Table 16).

Table 16

Music Composition Assessment Rubric Taken from Hickey (1998, p. 29).

Components	**Quality Line** *Needs Work*..*Terrific*!			
Aesthetic Appeal	Does not present an effective general impression. Musical Ideas do not hold the listener's interest.	Includes at least one interesting musical idea. Yet the overall impression is not effective.	Includes some interesting musical ideas. The general impression is pleasant and moderately effective.	Strong aesthetic appeal and general impression. Would be enjoyed by many listeners. Keeps the listener interested.
Creativity	Musical idea is familiar or cliché. No variety or exploration of musical elements (range, timbre, dynamics, tempo, rhythm, melody).	Musical idea is neither familiar nor a cliché. However there is no development, variety, or exploration of musical elements.	Involves some original aspect(s) or manipulation(s) of musical idea(s). Explores and varies at least one musical element.	Includes very original, unusual, or imaginative musical ideas. Explores and varies at least two musical elements.
Craftsmanship	Gives no sense of a completed musical idea. Exhibits no clear beginning, middle, or end section. Form appears random rather than organized. Musical elements (range,	Presents one complete musical idea. However, composition lacks overall completeness. Fails to use musical elements to organize musical ideas.	Ending feels final. Uses at least one musical element to organize the musical ideas and overall form.	Presents at least one complete musical idea. Has a coherent and organized form with a clear beginning, middle, and end. Uses musical elements to organize musical ideas or the form.

	dynamics, timbre, tempo, texture, rhythm, melody) do not connect well or are not used to organize musical ideas or the form.			

The compositions were converted to a format (e.g., MIDI) that could be played on common digital media players (e.g., iTunes©). Each composition was labeled with the student's first name and a number to represent which activity it was (e.g., Mike_4). Each student's composition was placed in their own individual playlist. Each student's playlist, which contained their compositions, was put on "shuffle mode" which allowed me to know whose compositions I was scoring, but not to know which specific composition it was.

It is important to understand what I felt makes a composition have high scores on creativity, aesthetic appeal, and craftsmanship. Prior to any scoring, I first listened to the composition and jotted down some simple descriptive notes that were meant as general first impressions. Table 17 shows my descriptive notes and the scores for the composition.

Table 17

Descriptive Notes on Students Composition and Their Corresponding Scores

Name	Composition	Notes	Score
Makenzie	Final	Default blocks used. Piano sound. Seems to be no exploration or development. Blocks seem random.	Creativity = 1 Aesthetic Appeal = 1 Craftsmanship = 1
Graham	Reconstruction	Fast tempo…not particularly pleasing to hear, but I like it. A definite beginning, middle, and end. Plays on too long. Pattern repeats three times, so it gets monotonous.	Creativity = 3 Aesthetic Appeal = 2 Craftsmanship = 4
Meredith	Reconstruction	Wow! This is really nice. A beginning, middle, and end. Obviously played with the tempo and slowed it down, but it is very pleasing. Changed instruments. Repeated certain blocks but still pleasing.	Creativity = 4 Aesthetic Appeal = 4 Craftsmanship = 4

When listening to the compositions I tended to want to place high scores for aesthetic appeal within accepted cultural norms. That is, I would ask myself if others would find it appealing. For example, Meredith’s composition was very pleasing to hear and I was sure that others would like it as well. Low scores for aesthetic appeal meant, for me, that I did not find the tune listenable nor did I think others would either. As an example, Mackenzie used the default, atonal, blocks for her composition that resulted in a composition that was not pleasing to hear.

For high scores on craftsmanship, I specifically listened for a structure (e.g., a beginning, middle, and end) and how the structure was carried out. This is represented in Graham’s composition where it was clear he had a beginning, middle, and end to his tune. Low scores on craftsmanship had little to no structure to the composition. Mackenzie seemed to place her blocks in a random order with no thought as to how they sounded.

Finally, for creativity, I scored tunes more highly that represented what I thought was an exploration of musical ideas (e.g., instrumentation, tempo, rhythm). Meredith explored both tempo and instrumentation in her composition which complimented the overall sound of the piece. For low scores on creativity, the tune reflected little to no exploration of musical ideas. Mackenzie’s composition kept with the default “piano” instrument and tempo setting.

After an initial listen, I reviewed the rubric and concentrate on one dimension (e.g., craftsmanship) and the levels associated with the dimension. I listened to the piece again and scored (from 1 to 4) the piece based on the rubric. I did this for each dimension. After each dimension was scored, I listened to the piece again and reviewed my scores to make sure they represented my judgment of the piece based on the criteria I was evaluating at the time.

A total of 95 out of a possible 108[14] compositions were collected from the participants. See Table 18 for breakdown of compositions collected at each time point.

Table 18

Breakdown of the Number of Compositions Collected at Each Time Point.

Composition Activity	N
Pre-Intervention Composition	29
Construction Activity Composition	30
Final Composition Activity	36
Total	95

This rubric was specifically chosen because it evaluated general criteria related to music composition rather than specific concepts (e.g., rondo form). Using the CAT to develop the rubric, Hickey (2001) found that general music/choral teachers had the highest inter-rater reliability (α = .81). That means when general music/choral teachers independently evaluated a music composition using their own definition of what was creative, aesthetically appealing, and well crafted, they agreed 81% if the time. The wording for the rubric was based on the music teachers' definitions of creativity, aesthetic appeal, and craftsmanship. Compositions were scored on a scale from 1 (needs work) to 4 (terrific) according to the rubric.

Before I evaluated all the compositions using the rubric, it was decided to test the assumption of the inter-rater reliability. To do this, 33 of the compositions (approximately 34%) were randomly selected, and the two external raters, who had experience in both music education and composition, listened to the compositions and independently scored them according to Hickey's rubric (1998) using the procedure described earlier. Scores were entered into SPSS and

[14] This total was produced by taking the number of participants (N = 36) and multiplying by the number of compositions collected (3), which equals 108.

a reliability coefficient of α = .84 was generated. This is consistent with Hickey's (2001) inter-rater reliability of the general music education teachers from which the rubric was designed.

Missing values

Before presenting the full analysis, an explanation of the missing data and how that was handled needs to be addressed. Over the course of each activity some student compositions were designated as missing. This was due to either technical issues in which the student either did not save the composition correctly, did not save their work at all, or if a student was absent. This was rare, but due to the relatively low participant numbers (N = 36) steps were taken to correct these missing compositions prior to any analysis.

First, all composition scores were inputted into SPSS. Scores that were missing were labeled accordingly (see Table 19 for example) (see Appendix B for full layout of scores and missing values).

Table 19

Example of Music Composition Scores Data Inputted in SPSS.

Student ID	**Aesthetic Appeal (Pre)**	**Aesthetic Appeal (Construction)**	**Aesthetic Appeal (Final Project)**
1	2	missing	3
2	missing	2	1
3	1	2	3

Before any analysis was conducted, a determination had to be made on whether the missing data was missing completely at random (MCAR) or not. This means that missing data was not related to any other data points (e.g., values of aesthetic appeal unrelated to creativity) and unrelated to values within the measure (e.g., values of aesthetic appeal at "Pre-Composition" vs. values at "Final") (Peugh & Enders, 2004). Little's (1988) MCAR analysis was conducted using

SPSS and the following output was observed: χ^2 (12) = 13.60, p = .327. Since the *p* value was greater than .05, the missing scores were not significant and the data was MCAR.

Since the data was MCAR, the missing values were replaced using the Expectation Maximization (EM) method in which an estimation of the missing values is made based on the data that was available. These estimations went through several iterations and the likelihood of the values is maximized (Borman, 2009). After five iterations[15], the missing values were replaced and used in the final analysis.

Analyzing the compositions

The research question in this chapter specifically addressed changes in creativity, aesthetic appeal, and craftsmanship of student compositions over time (e.g., pre, middle, and end). Therefore, a repeated measure ANOVA is most appropriate for this situation (Field, 2009). This is because (1) the compositions come from the same students throughout the study and (2) there are three points in the study that are of interests.

Prior to any repeated measure ANOVA, an analysis of whether or not the data violated the assumption of sphericity needs to be decided. Sphericity determines whether the differences between the treatment levels (e.g., pre, mid, and post) have equal variances. If this assumption is violated, then the interpretation of findings can be inaccurate. More specifically, not checking for this assumption could lead to accepting significant findings (e.g., compositions did improve over time not due to chance) when that is not the case (e.g., Type I error) (Field, 2009). To test for this assumption, SPSS conducts Mauchly's Test of Sphericity and if $p > .05$, then it can be assumed the variances are equal and sphericity has not been violated. However, if the assumption has been violated (e.g., $p < .05$), SPSS reports two separate corrections that may be

[15] It was observed, after the fifth iteration, that the change in the values was so small (e.g., beyond three decimal places) that there was no reason to report any other iteration.

used to interpret the data; the Greenhouse-Geisser correction and Huynh and Feldt correction. For the data set in this chapter the more conservative Greenhouse-Geisser correction has been reported if any of the data violated the assumption of sphericity.

To answer the research question addressed in this chapter, four separate repeated measure ANOVA's were carried out: one for overall creativity that collapsed all scores from aesthetic appeal, creativity, and craftsmanship into one score for each; one for creativity; one for aesthetic appeal; and one for craftsmanship. Post-hoc analysis using the Bonferroni method was also conducted on the data to determine if there were differences between the specific time points (e.g., Pre versus Final). This analysis was used because it is the most robust and conservative relative to the number of participants and conditions and controls best for Type I error rates (e.g., observing significance when there is none).

Findings

RQ 1 - Based on a general assessment of music composition, do student compositions reflect a greater sense of aesthetic appeal, craftsmanship, and creativity at specific time points?

Overview

The following section will be broken down into four separate sub-sections based on the category being measured (overall scores, creativity, aesthetic appeal, and craftsmanship). Each section will first present descriptive data (means and standard deviations) and then address the assumptions of the data (e.g., sphericity) and whether or not the data violated this assumption. There will then be a presentation of the repeated measures ANOVA analysis and post-hoc analysis for each category. Implications of the findings will be discussed after the data from all the categories will be presented.

Overall Scores

Before parsing out the separate dimension used in the rubric, overall scores were generated by combining the scores of each dimension (e.g., creativity, craftsmanship, aesthetic appeal). Table 20 provides a breakdown of the overall scores at each time point, including the means and standard deviations.

Table 20

Mean and Standard Deviation of the Overall Scores Separated by Time Point.

	Mean	**Standard Deviation**	**N**
Overall Score – Pre-Composition	5.69	1.91	36
Overall Score – Construction	6.11	2.22	36
Overall Score – Final	6.36	1.15	36

The test of sphericity found that the data did not violate this assumption, $\chi^2(2) = 3.77$, $p > .05$ and no correction needed to be made. It was observed that there were no significant differences in the overall scores over time, $F(2, 70) = 4.04$, $p = .269$. Post-hoc analysis was conducted and found that there were no statistically significant differences in overall scores between the "Pre-Composition" and "Construction", "Pre-Composition" and "Final", and "Construction" and "Final". Table 21 breaks down these comparisons.

Table 21

Post-Hoc Comparisons of Overall Scores Using the Bonferroni Correction of "Pre-Composition" and "Construction" and "Pre-Composition" and "Final" Compositions.

	Mean Difference	**Significance**
"Pre" vs. "Construction" (Overall Score)	- 0.416	1.00
"Pre" vs. "Final" (Overall Score)	- 0.663	.202
"Construction" vs. "Final" (Overall Score)	- 0.247	1.00

The overall scores were not significant, which means that the changes could be by chance only. Therefore, any assumption about whether scores on overall creativity at the different time points was not appropriate.

Creativity

According to the rubric (Hickey, 1998), the compositions during the both the "Pre-Composition" and "Construction" time point may have exhibited one original idea, but there was little exploration, variety, or development of the composition. Table 22 breaks down the creativity scores at each time point.

Table 22

Mean and Standard Deviation of Creativity Scores Separated by Time Point.

	Mean	**Standard Deviation**	**N**
Creativity – Pre-Composition	2.22	.823	36
Creativity – Construction	2.53	.887	36
Creativity – Final	1.81	.668	36

Mauchly's Test of Sphericity found that the data for creativity scores did not violate the sphericity assumption, χ^2 (2) = .019, $p > .05$. Since the data did not violate the sphericity assumption, no correction had to be made and it was observed that there was a significant difference in creativity scores over time, F (2, 70) = 10.335, $p < .001$. What this means is that scores on creativity did significantly change over time and the difference in scores was not due to chance and that time did impact the scores. However, the difference in scores was a decrease rather than an increase and will be addressed after the post-hoc test are presented.

Post-hoc analysis revealed that between the "Pre" and "Final" and "Construction" and "Final" compositions, there were significant differences in creativity scores, while there was no significant difference between the "Pre" and "Construction" compositions (see Table 23).

Table 23

Post-Hoc Comparisons of Creativity Scores Using the Bonferroni correction of "Pre-Composition" and "Construction" and "Pre-Composition" and "Final" Compositions.

	Mean Difference	**Significance**
"Pre" vs. "Construction" (Creativity)	- 0.309	0.184
"Pre" vs. "Final" (Creativity)	0.420*	0.043*
"Construction" vs. "Final" (Creativity)	0.728*	0.000*

** Indicates the Mean Difference score is significant at the 0.05 level*

The differences between the "Pre" and "Final" and "Construction" and "Final" compositions were significant. However, the difference is that student creativity declined significantly during the "Final" composition rather than increasing. This is not entirely surprising. The Pre-Composition activity was done when students had no interaction with the tool or music composition as a structured activity. So the students were not primed on what a composition should sound like or how it should be constructed. They were able to explore their thinking and take advantage of what was given to them. Also, as a pedagogical practice, I encouraged students to talk about what it was they were creating. These conversations normally centered on what sounded good (or not) and why. Therefore, encouraging an exploration of musical elements and originality were not made explicit. As an example, when students were composing their final tunes, they had many discussions about, for example, what they were hearing in relation to what they knew (culturally), what makes a beginning, middle, and end of a tune, and the function of pitches and tempo (e.g., that sounds good/bad). This, along with limitations in navigating the Impromptu interface, may have limited their time to explore their musical ideas.

Aesthetic Appeal

Table 24 provides a breakdown of aesthetic appeal at each time point, including the means and standard deviations.

Table 24

Mean and Standard Deviation of Aesthetic Appeal Scores Separated by Time Point.

	Mean	**Standard Deviation**	**N**
Aesthetic Appeal – Pre-Composition	1.70	.823	36
Aesthetic Appeal – Construction	1.81	.887	36
Aesthetic Appeal – Final	1.97	.167	36

The test of sphericity found that the data for aesthetic appeal violated this assumption, χ^2 (2) = 15.299, $p < .05$. Using the Greenhouse-Geisser correction, there were no significant differences in aesthetic appeal scores over time, F (1.47, 51.38) = 1.258, $p = .284$. What this means is that the aesthetic appeal in student compositions did not significantly change over time. Post-hoc analysis was conducted to determine if there were significant differences between any two of the time points.

Post-hoc analysis found that there were no significant differences in aesthetic appeal between the “Pre-Composition” and “Construction”, “Pre-Composition” and “Final”, and “Construction” and “Final”. Table 25 breaks down these comparisons.

Table 25

Post-Hoc Comparisons of Aesthetic Appeal using the Bonferroni correction of “Pre-Composition” and “Construction” and “Pre-Composition” and “Final” Compositions.

	Mean Difference	**Significance**
“Pre” vs. “Construction” (Aesthetic Appeal)	- 0.110	1.00
“Pre” vs. “Final” (Aesthetic Appeal)	- 0.271	.191
“Construction” vs. “Final” (Aesthetic Appeal)	- 0.161	.834

It is possible that the combination of the low participant number (N = 36), missing data, and violation of sphericity contributed to not finding a significant difference when there could be one (e.g., Type II error). However, using the more conservative Greenhouse-Geisser and Bonferroni corrections allows for a more accurate representation of the data (Field, 2009). Since findings were not significant, it is inappropriate to discuss possible reasons why scores increased, as it may just be due to chance alone.

Craftsmanship

The craftsmanship of the composition highlights whether the student utilized coherent musical ideas and put them to use in the composition (e.g., the tune has a beginning, middle, and end). Overall, scores on craftsmanship increased over time (see Table 26).

Table 26

Mean and Standard Deviation Craftsmanship Scores Separated by Time Point.

	Mean	**Standard Deviation**	**N**
Craftsmanship – Pre-Composition	1.72	0.882	36
Craftsmanship – Construction	1.78	0.895	36
Craftsmanship – Final	2.58	0.691	36

The test of sphericity for the craftsmanship scores showed that the data did not violate this assumption, $\chi^2(2) = .441$, $p > .05$. This means that no corrections needed to be made for further analysis. Overall, scores on craftsmanship differed significantly over time, $F(2, 70) = 13.303$, $p < .001$. This means that the difference in the scores over time was not due to chance. Post-hoc analysis further revealed that between the “Pre” and “Final” and the “Construction” and “Final” there were significant differences in the scores (see Table 27).

Table 27

Post-Hoc Comparisons of Craftsmanship Scores Using the Bonferroni correction of "Pre-Composition" and "Construction" and "Pre-Composition" and "Final" Compositions.

	Mean Difference	**Significance**
"Pre" vs. "Construction" (Craftsmanship)	- 0.068	1.000
"Pre" vs. "Final" (Craftsmanship)	- 0.867*	0.000*
"Construction" vs. "Final" (Craftsmanship)	- 0.799*	0.001*

** Indicates the Mean Difference score is significant at the 0.05 level*

Craftsmanship scores on student compositions increased over time and most notably between the "Pre" and "Final" compositions. Overall, this shows that students seemed to have a completed musical idea and their tune included what I, as the evaluator, considered some semblance of structure (i.e., beginning, middle, and end). Unlike the other scores on aesthetic appeal and creativity, the scores on craftsmanship significantly improve, suggesting that students concerned themselves with the overall organization of the composition as time progressed.

While significant, it does make sense as to why scores increased, based on the learning activities in which the student engaged. By that, the score reflected exactly what the students were taught to do based on the confines of the tools and materials at their disposal and the curriculum. Students were constantly being asked questions like "how do you like the sound of that tuneblock?" or "why does that sound weird to you?" This lent itself to students creating a well-crafted tune. Impromptu promotes this dimension by providing users with tuneblocks rather than individual notes.

The findings in this section show that students' compositions did reflect a greater sense of craftsmanship over time. Specifically, these differences were observed between the Pre and Final activity and the Construction and Final activity. These findings contradict the observations from Seddon and O'Neill (2003) that suggest learners with no formal musical (instrument) training focus less on crafting and more on exploring. While they suggest that their lack of formal knowledge opens up avenues for exploration using the computer, I contend it is not the technology alone that dictates or guides creativity. It is an interaction of the learner's culture, motivations, and tools (e.g., technology) that guides creativity. Specifically, participants in this study spent a good amount of time discussing how they want their song(s) to sound in relation to what they already knew culturally from other media outlets (e.g., movies, radio, and television). It is quite possible that their exploration of the musical landscape for the sake of being imaginative was not applicable because they already had an idea of what they wanted their song to sound like. Therefore, crafting a tune in a specific, culturally determined, manner was most important.

Limitations and Discussion

This section examines the limitations of the study involving the tool (Impromptu), the curriculum, the non-randomization of participants, the time for each activity, and technical issues (e.g., missing data). Future research trajectories that address the limitations are presented. Lastly, a discussion of the impact of these findings is discussed.

Impromptu was designed as a learning tool, a tool that allows users to question their intuitions about music. While this is an affordance of Impromptu on the dimension of craftsmanship, it may be a limitation to creativity. As with any music creation software tool, there needs to be a certain amount of familiarity with the tool in order to navigate the user interface. Impromptu is arguably more difficult due to the specific design decisions based on the theoretical framework (e.g., intuitions and constructionism) used in designing the interface. That is, the main assumption of the tool is that it starts out with what users already intuitively know about music. This could explain how scores in creativity significantly declined from the first to final composition. Expanded further, in order to really explore nuanced musical ideas from whole tunes to single note manipulation in Impromptu, users need to understand how to edit and/or make new blocks, change instruments, and make use of multi-channel production (i.e., multiple instruments playing different parts).

The curriculum was also a limitation in that students were taught certain things throughout the intervention. This was a byproduct of the constructionist designed tool and curriculum. More specifically, the activities were designed so that certain concepts emerged and became useful during the music composition process. For example, when reconstructing the tune Hot Cross Buns, there are only two tuneblocks available to the user ("hot cross buns" and "one-a-penny, two-a-penny"). As the user listened and began to reconstruct the tune, she realized that repetition plays a role when composing a tune.

Common themes in the literature on music technology and pedagogy suggests that technology promotes active engagement in music activities (i.e., composing, altering, mixing, listening) and that teachers need to be open to new ideas and approaches to student learning with technology (c.f., Webster, 2006). Burnard (2007) adds that technology can change how a teacher teaches, for better or worse. While the goal was to investigate how creativity was impacted when engaging in computer-aided music composition activities, it was possible that some pedagogical practices placed more value on certain dimensions of creativity than others. As an example, I often asked students what they thought when they heard a tuneblock and then followed up with a "why" question. The discourse that emerged from these types of interactions usually involved how the tune or tuneblock sounded in relation to some cultural standard. Since no further follow-up occurred, students were not exposed to the types of musical exploration that could be done. This is not to say that the activities were devoid of any exploration. However, this exploration was treated as a means to an end rather than a learning opportunity. More specifically, when topics emerged in class discussions about how to change, for example, instrument sounds or tempo, I showed them the procedure without engaging the students further as to why this is an important thing to do.

This is not to say the time-based analysis used in this study was not useful. To the contrary, this research suggests that students cared about how their music was composed, as reflected in their craftsmanship scores. These findings show that specifically teaching and modeling the dimensions of creativity that are being measured should be integrated into the pedagogy. This research also highlights the importance of computer-aided music composition in learning. This is because being able to compose, regardless of the prior/formal knowledge the learner has, requires a process analogous to scientific thinking (Kaschub & Smith, 2009).

I was unable to locate any prior research specifically using Hickey's (1998) general musical assessment rubric in evaluating fourth-grade students' compositions. Similar studies involving creativity and music composition utilized qualitative methodologies (Nillson & Folkstead, 2005; Seddon & O'Neill, 2003) that evaluated creative thinking and or the creative product. One study that used quantitative measures based on a rubric was conducted by Kuehne, Lundstrom, and Walls, (2013). However, their rubric was specific to certain musical concepts (e.g., ABA form) and their operational definition of creativity was dependent on both the evaluation of the whole song that was composed and whether or not the composer used specific musical concepts. This led to inconclusive results related to creativity. Similarly, Auh and Walker (1999) used a rubric that parsed out creativity into originality, musical syntax (e.g., craftsmanship), and artistic sensitivity (e.g., aesthetics). While they found statistically significant differences between their groups, the inter-rater reliability between judges was $r = .71$ and their activities did not include technology.

Other limitations included randomization of participants, time, and technological issues. Regarding randomization of participants, it could have been possible to get other students in the school, from different grades, to be a control group (e.g., not engage in the Impromptu curriculum); however, research has shown that there may be developmental differences in the way students engage in composing music and creativity may emerge with multiple experiences in composing music (Kratus, 1998; Levi, 1991), which could have skewed findings depending on the age-range of the control group.

The time students spent on the activities was also an issue. The 20-hour curriculum included both whole-class and individual activities. It is quite possible that if students were given more time to work on their compositions, their scores may have increased. More specifically, if students were given more time to figure out how to navigate the Impromptu interface more effectively and efficiently, then more time could have been spent, for example, on composing a more creative tune. Technologically speaking, students in this class were just starting to learn how to create, save, organize, and send (e.g., email to teachers), for example, word processing files on a computer. While saving an Impromptu file is similar to saving word processing files, some Impromptu files were not saved correctly or not saved at all. This led to missing data. While conservative statistical measures were taken to correct for this, it still limits the findings and the claims being made.

The findings in this chapter present teachers with an exciting challenge of designing curriculum that draws upon the dimensions of creativity that are outlined in the rubric. More specifically, the rubric can be a guide to design experiences for students in which they learn what it means to be creative, but to construct an artifact that is also aesthetically appealing and well crafted. The findings in this chapter reflect that the experiences students had (e.g., discussing what makes a tune good) are demonstrated in their artifacts.

Further research needs to be done to address these limitations. Logistically, it would be advantageous to use multiple groups using different music making tools that include everything from analog instruments to digital production tools (e.g., GarageBand©). Also, future research and pedagogical approaches should allot more time for students to not only navigate and understand the tools there are using, but to truly explore their musical ideas. Also, it would be interesting to investigate different types of instruction and how that impacts creativity. For example, groups could be set up where one group would be taught specific musical concepts, ideas, and terms, and another group would freely explore their musical ideas and only call on the teacher when needed.

Pedagogically, giving students a chance to make their own melodies using the computer is an important activity to participate in because it provides, what Wiggins (2009) calls, a “doorway in”. Using tools like Impromptu, or even more commercial types of software like GarageBand and its use of loops (i.e., equivalent to the tuneblocks in Impromptu), provides the beginning music learner the ability to start off with things that are meaningful to them and then move to more formal constructs (e.g., pitches, rhythm).

The landscape of music education and the pedagogical approaches used to engage learners is ever-changing. The research presented in this chapter provides empirical evidence that an intuitive approach to music learning that emphasizes creation, musical intuitions, and technology positively impacts craftsmanship and more specifically the importance the learner places on how the artifact is put together. Because creativity is a valued skill for future success in life (Partnership for 21st Century Skills, 2009; Sternberg & Lubard, 1999), this type of approach may be beneficial for those, both in and out of the arts, to include in their curricular and pedagogical designs.

CHAPTER FIVE

Significance of the Study

Overview

The research conducted in this dissertation haDs revealed the importance of intuitions and their impact on learning. Research involving intuitions, especially in the Learning Sciences, has labeled intuitions as either misconceptions, naïve conceptions, or false beliefs (c.f., Smith, diSessa, & Roschell, 1994), or has simply failed to define what intuitions are even though they are an important factor in learning (c.f., Resnick & Wilenski, 1998; Clement, 1993; Zietsman & Clement, 1997). Also, studies on intuitions have only looked at, for example, what the learner knows about a certain concept (e.g., Ohm's Law) and not the interplay between the practitioner, the artifact the student constructs, and the reflective processes involved during the design (e.g., construction/composition) process. The research in this dissertation has shown that this interaction is key in understanding how intuitions impact learning.

The purpose of this chapter is to provide a summary of the findings of each chapter, general discussion points, limitations, and future directions for study, and more specifically, the interaction between practitioner, student discourse, and the artifact. I will begin with the findings from Chapter Two regarding the role of the practitioner in eliciting intuitive responses from students. Chapter Three will then be discussed regarding student's domain engagement through their discourse using reflection-in-action and reflection-on-action during open-ended and goal-oriented activities. There will then be an exploration of Chapter Four and the implications of student's creativity when they engage in intuitive music composition activities.

Chapter Two

The traditional paradigm of a teacher asking questions of a student, the student responding, and the teacher evaluating the response has been challenged by many (Cazden, 1986; Gresalfi, 2001; Lemke; 1990; van Zee & Minstrell, 1997 Weinbaum, et al., 2004). The main concern is that this approach leaves little opportunity for the student to engage with the domain at a level that he or she finds meaningful (Gresalfi, 2001; van Zee & Minstrell, 1997). Research has shown that when students are prompted to explain their thinking, their learning of the domain increases (Chi, et al., 1989; Chi et al., 1994). What is unclear from this literature is whether younger, less experienced students in a domain (e.g., music) can engage in explanations of a phenomenon using the intuitions they have and how the practitioner can specifically promote this engagement.

The research in this chapter was guided by the questions:

- What role does the practitioner have in scaffolding intuitive explanations? and,
- What types of question elicit engagement within the structural musical ladder?

Findings suggest that the practitioner plays a crucial role in scaffolding intuitive explanations (RQ1). More specifically, the practitioner engaged students by asking those questions 137 times over the course of the whole class activities. This is 32.61% of all the utterances made, and while it may seem like the practitioner is dominating the conversations, this is not the case. The practitioner is engaging students in short, poignant questions (i.e., how, what, and why) that are meant to elicit response from the students.

The literature on prompting students suggests this is a positive thing to do in that it increases learning in the domain (c.f., Chi, et al., 1989; Chi, et al., 1994). The framework (c.f., Bamberger, 1996; Papert, 1980; 1991) used in this dissertation highlights that new music learners should start with what they know about (e.g., their intuitions). This allows them to move to more sophisticated knowledge while engaged in a constructive activity. The research conducted in this chapter specifically looked at the types of questions asked by the practitioner that mapped onto Bamberger's (1996) structural musical ladder, more specifically, the questions that prompted learners to go beyond what they already intuitively knew.

It was found that asking "why" and "what" questions promoted more engagement in low- and high-level musical structures. This is important because these structures are not typically known to the new music learner (i.e., it is beyond their intuitions). Conversely, asking "how" questions did not seem to have an impact on the students' movement within the structural musical ladder. That is, "how" questions are process or action related: how to do something. These types of questions, however, should still be asked, especially during a constructionist type activity because it requires the student to think about how something works when followed up with a "what" or "why" question.

The significance of these findings is two-fold. First, students bring very powerful and useful intuitions to a learning situation that need to be valued and emphasized. Even students with little to no formal background knowledge were able to engage deeply with a domain that was once thought to require years of schooling and practice. Teachers can and should be actively involved in doing what they can to elicit these intuitions by asking short, but poignant, questions that prompt students to explain their thinking beyond just giving the right answer to a question. Doing so gives the teacher the opportunity to better evaluate what the student knows about the domain, what should be known, and how to best alter activities to achieve the knowledge that is being sought.

Second, the findings in this chapter provide empirical evidence to the specific types of questions that elicit responses in which the student must engage thinking beyond the surface level features of the phenomenon in question. More specifically, asking students “why?” puts the responsibility on the individual student. Students engaging in discourse in which they explain their thinking is an underutilized practice, especially in constructionist activities. However, these findings provide a way in which teachers can engage students in a productive and meaningful discourse.

Furthermore, this research provides a curricular design that promotes students engaging in making something. The processes of constructing an artifact promote a student’s ability to think and reflect. Engaging students by asking them about what they are creating promotes more reasoned responses that are important for policy in today’s educational climate. More specifically, there is an emphasis being placed on students explaining their thinking processes in school settings (i.e., goals of the Common Core curriculum), and this research gives policy makers a way to allow teachers to produce this outcome both pedagogically (i.e., asking questions) and through curricular designs (e.g., constructing an artifact).

Limitations to the research in this chapter include relatively low participant numbers and not being able to randomize the students into different groups. This limits the generalizability of the claims being made and may impact the findings being reported—specifically finding significance where there is none and/or not finding significance where there should. Further, because I acted as the teacher/practitioner in this study, this may have presented some bias to the researcher. However, my experience in engaging students during music activities, my professional work with music technology, years of practice as a musician, and using outside raters to code data help curb this limitation.

Future directions of research should find ways to randomize participants to different experimental conditions. For example, what would the impact be if the questions asked came from other students rather or a computer program rather than the teacher. This will allow a better understanding of whether it is the teacher that is important or asking the question that is important. Another route would be the type of design activity in which these questions occur. This research advocates a constructionist type activity. How, then, might this be applied in a more read-and-respond type of approach or even a direct instruction type of environment? This will shed light on which activity is best suited for this type of intuitively deep engagement.

Chapter Three

Being able to reflect on a situation or event is a key factor in learning (Bransford, Brown, & Cocking; 2000; Sawyer, 2006). Professionals and experts often use this metacognitive strategy of reflection in their daily practice, what Schön (1983) calls reflecting-in-action and reflecting-on-action. Schön (1983) suggest that professionals / experts rely on their intuitions in order to reflect on how and what it is they do. An intuition, as I have defined the term based on the existing literature, is a mechanism that guides the use and construction of knowledge when someone is interacting with their world. More specifically, these intuitions are more powerful and useful when they can be used in conjunction with making something (e.g., composing a piece of music). However, if reflecting is important in learning and professionals/experts engage in reflection during their practice, what does this mean for younger students who are not on the level of the professional/expert? Do students use their intuitions to reflect on what it is they are doing or have done, and are there curricular design approaches that can encourage this reflection? Specifically, this chapter was guided by the overarching question: How can we shape design activities, particularly through the design goals and reflection practice, to promote high quality learning and domain engagement? More specifically:

- When fourth-grade students engage in both reflection-in-action and reflection-on-action, which type of reflection seems to promote greater domain engagement? How are the domain specific responses (i.e., advanced musical concepts) distributed during each activity? and;
- What impact does the type of activity have on student's sophisticated discourse in the domain?

Findings provided evidence that when students reflect both in- and on-action, they engage in a sophisticated musical discourse over time. Activities in which students worked as a whole-class (i.e., reflection-in-action) garnered 59.83% of musical responses compared to 40.16% of musical responses happening when students worked alone (i.e., reflection-on-action). Important to these findings is the deep engagement in musical discourse that emerged as students engaged in composing a piece of music (e.g., high and low-level structure responses). It was observed that these high- and low-level structure responses increased over the course of the activities, which indicate that students engage deeper with the domain as time progresses. Further still, it was found that the type of activity the students engage in impacts their engagement. Specifically, open-ended activities significantly impact the students' use of sophisticated musical discourse. That is, students use low- and high-level structure responses more during open-ended activities than during goal-oriented activities.

Limitations included the inequality of the reflective activities. That is, students were not required to write in their journals or participate in class if they did not want to. Using both qualitative and quantitative support helps curb this limitation. To that end, generalizing the claims to a larger population is a limitation. However, this research looks at the process of learning that happened both over the long term as well as from a micro approach.

These findings are significant in that they suggest that students, with no formal training or background knowledge, can and do engage with a domain using discourse important to the domain (e.g., music). Specifically, when students are given the opportunity to reflect on what it is they are doing, it encourages this type of discourse. This is significant because (1) reflection is a key component in learning and (2) it was thought that only experts / professionals engaged in this practice. The research in this chapter supports the idea that young students can engage in a reflective practice that results in deep learning and engagement in the domain.

Even more important is the idea that the type of design activity the student engages in impacts the engagement (e.g., use of sophisticated discourse). This provides support that creative and open-ended activities are better suited than goal-oriented activities in promoting engagement in the domain. Researchers, teachers, and policy makers can now explore the possibilities that creative activities have on a student's learning.

Future research designs should be sure to incorporate the possibility of engaging everyone in the reflection process. This could include breaking the class into small groups (three to six per group) or offering different modalities with which students can engage in reflection. This could include, writing, talking, drawing, or other modes of expression. Further still, future research should also investigate just how these reflective practices and design activities (i.e., open-ended) impact collaborative learning and engagement. Specifically, investigating whether there is an optimal number of people in a group or a specific modality to encourage reflection and engagement in the domain could hold promise. Finally, future research should compare different domains. While the research here promotes the domain of music, it is unclear whether these types of reflective practices would be beneficial in, for example, a math or science activity.

Chapter Four

Important in any constructionist activity is the artifact that is being produced. The research in this dissertation is grounded in constructionist activities (e.g., composing music) with an emphasis on students using their intuitions to guide this construction process. These intuitions are important because they guide student engagement in an activity and help in the construction of knowledge. Also, the activities in this dissertation were not geared toward instructing or introducing terminology or practices that are specific to the domain. That is, it was the goal of the research in this dissertation to allow students to construct the knowledge they needed in order to engage the domain and hence emphasize creative approaches to the construction process. What is missing in the literature is whether a student's creativity and other dimensions of creativity (i.e., aesthetic appeal and craftsmanship) are impacted when they engage in intuitive, constructionist activities. Specifically I asked:

- Based on standard assessments of music composition, do students' compositions reflect a greater sense of aesthetic appeal, creativity, and craftsmanship at specific time points?

It was observed that overall scores on creativity increased over time. When looking at specific dimensions of creativity, scores on aesthetic appeal increased and scores significantly increased on craftsmanship. This means that as time progresses, students think and care about how their piece of music is crafted and how it will sound. This is reminiscent of what professional composers concern themselves with when they compose a piece of music (Bennett, 1976; Glover, 2000).

Limitations include low participant numbers and the issue of missing data. While the number of students in this study was the entire fourth-grade population (N = 36), it still limits the claims being made to a wider population. Regarding missing data, some student compositions were either not saved correctly, resulting in a corrupted computer file, or not saved at all. Statistical measure were taken to address this limitation. Finally, time was an issue in that students were tasked with composing a tune in a relatively short amount of time, considering all that is needed to engage in composing a tune. However, what has been gleaned from this and other chapters is the idea that even small amounts of time have a positive impact on student learning and engagement.

This study provides empirical support to the idea that creative, open-ended constructionist type activities, like music composition, positively impacts dimensions of a student's creativity. Important in the 21st century is for learners to have skills in which they can effectively and creatively solve novel problems they encounter in the world. Teachers and policy makers can be comfortable in knowing that when students engage in making something they find meaningful, they care about dimensions of creativity, including how their artifact is being constructed and how it will be perceived. Further still, this research promotes the idea that using general evaluation procedures (e.g., not tied to any formal concepts) is effective in evaluating an artifact.

Future research approaches should investigate how teachers would use this evaluation tool to guide their designs of future activities. Also, research should be designed to randomize students to conditions in which they are aware of the evaluative parameters, those that know they are being evaluated but do not know the specifics, and those that do not know if they are being evaluated. This will shed light on what students find important when they are creating something. Finally, prior to collecting any data using a tool like Impromptu, students should be given as much time to explore the interface as much as possible. The research conducted in this chapter only gave minimal exploration time with a specific time at the end of the study (prior to the Final Project) dedicated to making tuneblocks from scratch. Doing this will allow students to fully explore their thinking from the beginning.

Concluding Discussion

The Learning Sciences have long been considered an interdisciplinary study of learning (Kolodner, 1991; Sawyer, 2006). However, music is a domain that is non-existent in the literature in the Learning Sciences. If the goal of the Learning Sciences is a true interdisciplinary study of learning, then areas that include music and other arts and creative domains need to be included in the study of learning. The research in this dissertation has shown that, even over small amounts of time, young children can think and produce materials that are beyond what was initially thought to be developmentally appropriate.

For educators and practitioners, this research has shown that (1) engaging young learners in a discourse that values intuitions is important, and (2) activities grounded in practices that encourage children to be actively involved in making a tangible artifact helps in the construction of knowledge.   In a constructionist environment, the importance of the teacher cannot be understated because they play a pivotal role in recognizing when to ask questions and when to listen to student's explanations (Weinbaum, Allen, Blythe, Simon, Seidel, & Ruben, 2004). When teachers place more emphasis on letting the students express their intuitions, they can then evaluate where the learner may need extra support in understanding the domain in which they are currently engaging. Also, when students produce artifacts, they are able to navigate their relationship to the domain (e.g., music) and to the community as a whole (Pinkett, 2000).

Also, pedagogical practices in music have long been concerned with starting out new music learners with nuanced ideas that contradict intuitions and thus produce difficulties in learning (Bamberger, 1996). This research has shown that giving students, especially those with no formal training or lessons, the opportunity to make music starting out at a mid-level structure allows them to discover and learn formalisms (e.g., pitch) that are important. Furthermore, curricular designs grounded in a constructionist theory of learning and teaching and mediated by technology may be advantageous for music educators because they encourage students to engage in what musicians do (e.g., create music).

Finally, policy makers can use the findings in this dissertation to help influence practices that encourage students to express their thinking in a classroom environment. More specifically, the culture of education praxis is largely dominated by high-stakes testing and the preparation of students to engage with these high-stakes tests. This leaves little opportunity for students to express their thoughts and even less time for teachers to evaluate what the students know and do not know.

Key components to 21st century learning involve concepts including communication and creativity while being able to effectively use technology in core subjects that include the arts (Partnership for 21st Century Learning Skills, 2009). The research in this dissertation promotes an alternate pathway to promoting creativity and innovation. The findings in this dissertation suggests that when students are explaining their thinking while engaged in making something, they are creating and articulating new ideas, listening, and reflecting. Each of these is essential for students to engage in if they are to succeed in the 21st century (Partnership for 21st Century Learning Skills, 2009).

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APPENDICES

Appendix A

CODING GUIDE:
The GIR and RIR

Introduction:

Intuitions provide a grounding in which learners can approach, view, and potentially solve problems they encounter, (Noddings and Shore, 1984; Fischbein, 1987; diSessa, 1993; Hogarth, 2001; Bowers et al., 1990; Burton, 1999). It is my contention that intuitions can be powerful when learners are given a chance to express and use their intuitions.

To investigate intuitions, students will be participating in a series of musical composition activities that encourages intuition use. Data for these codes are drawn from audio transcriptions of whole class work as well as written reflections of students' individual work. Data will be separated by each person who is talking which can be as short as a word or two, or a as long as needed for the persons turn to be completed.

Below is a table that explains the coding scheme developed for these activities. These codes are not exclusive to each data point. That means any combination of codes can be used on a data point

CODE NAME	CODE	EXPLANATION	EXAMPLE
General Intuitive Response	GIR	When a student expresses an idea or thought but does not go beyond any surface level explanations. The resulting meaning is general and does not imply any further justification, inference, and speculation beyond their initial response. It does not have to be a full explanation.	Some possible examples could be: **Student X:** *"I don't like the blue block there, it just sounds weird"* or **Student Y:** *"I like the tune, but it is too fast"*
Reasoned Intuitive Response	RIR	When a learner expresses an idea or thought about a particular phenomena AND explains their thoughts by justifying, inferring, or speculating	Using the examples from above: **Student X:** *"I don't like the blue block there, it just sounds weird 'cause the block before it is really nice and pretty sounding, and the*

		for the reasons the phenomena is the way it is. (e.g., gives a reason)	*blue block just to jumbled"* or **Student Y***"I like the tune, but it's to fast which makes it hard to hear what is going on."*

Appendix B

Data entry for composition scores at each time point with inclusion of missing data.

Student ID	Pre-Intervention Composition (Creativity)	Pre-Intervention Composition (Aesthetic Appeal)	Pre-Intervention Composition (Craftsmanship)	Construction Activity (Creativity)	Construction Activity (Aesthetic Appeal)	Construction Activity (Craftsmanship)	Final Project (Creativity)	Final Project (Aesthetic Appeal)	Final Project (Craftsmanship)
1	3	2	1	1	1	1	2	2	3
2	2	1	1	3	1	1	2	2	4
3	2	1	2	2	2	2	2	2	3
4	2	2	3	3	3	3	3	2	3
5	Missing	Missing	Missing	2	2	2	2	2	3
6	Missing	Missing	Missing	Missing	Missing	Missing	1	2	3
7	Missing	Missing	Missing	3	3	3	2	2	3
8	2	1	1	Missing	Missing	Missing	1	2	1
9	3	1	1	3	1	1	3	2	3
10	2	3	2	3	1	1	2	2	3
11	3	3	2	3	1	1	1	2	2
12	2	2	1	1	1	1	1	2	3
13	Missing	Missing	Missing	3	1	1	1	2	3
14	1	1	1	3	1	1	2	2	4
15	1	1	1	1	1	1	1	2	2
16	Missing	Missing	Missing	3	3	1	2	2	2
17	2	1	1	Missing	Missing	Missing	2	2	2
18	Missing	Missing	Missing	3	2	2	2	2	2
19	2	2	2	3	1	1	2	2	3
20	1	1	2	1	1	1	2	2	3
21	1	1	1	3	2	2	1	2	2
22	2	1	1	3	4	4	2	2	3
23	2	1	1	3	2	2	1	2	2
24	3	2	3	3	1	1	1	2	2
25	3	2	2	3	2	3	2	2	3
26	3	1	1	1	1	1	2	2	2

Student ID	Pre-Intervention Composition (Creativity)	Pre-Intervention Composition (Aesthetic Appeal)	Pre-Intervention Composition (Craftsmanship)	Constructio n Activity (Creativity)	Construction Activity (Aesthetic Appeal)	Construction Activity (Craftsmanship)	Final Project (Creativity)	Final Project (Aesthetic Appeal)	Final Project (Craftsmanship)
27	2	1	2	3	3	3	2	2	1
28	3	2	2	3	2	2	1	2	2
29	1	3	2	1	1	1	1	2	2
30	Missing	Missing	Missing	4	4	4	2	2	2
31	3	2	1	3	3	3	1	2	3
32	4	4	4	3	2	2	3	2	3
33	2	2	3	Missing	Missing	Missing	3	2	3
34	1	1	1	Missing	Missing	Missing	3	2	3
35	3	3	4	Missing	Missing	Missing	2	2	3
36	3	2	2	2	1	1	2	1	2

Curriculum Vitae

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- Portowitz, A., Peppler, K. A., **Downton, M. P.,** & Lichtenstein, O. (in press). In Harmony: A technology-based music education program designed to improve children's musical understanding and general cognitive and social skills. *International Journal of Music Educaiton.*
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Conference Presentations

- **Downton, M. P.** 2013. Asking the why questions. Presentation for the Arts and Learning Special Interest Group at the 2013 American Education Research (AERA) Conference. Philadelphia, PA.
- **Downton, M. P**., Peppler, K. A., and Bamberger, J. (2012). Collaborative Meaning Making in Music: Youths' Discourse During Computer Aided Composition. Paper to be presented at the 2012 National Association for Music Education (NAfME) Music Creativity Special Research Interest Group. St. Louis, MO.
- **Downton, M. P**., Peppler, K. A., Bamberger, J. (2011). Talking like a composer: Negotiating shared musical compositions using *Impromptu*. Presentation at the 2011 Computer Supported Collabortive Learning (CSCL) Conference, Hong Kong.
- **Downton, M. P**., Peppler, K.A., Portowitz, A. Lindsey, E., and Bamberger, J. (2011). Pieces for peace: Using *Impromptu* to build musical and cross-cultural understanding. Presentation at the 2011 American Education Research Association (AERA) Conference, New Orleans, LA.
- **Downton, M. P**., Peppler, K. A., Portowitz, A., and Bamberger, J. (2010). A view of creativity as learning: *Impromptu* and Playing across cultural divides. Presentation at the 2010 College Music Society Conference, Minneapolis, MN
- **Downton, M. P**., Peppler, K. A., and Portowitz, A. (August, 2010). *Building tunes block by block: Constructing musical and cross-cultural understanding using Impromptu.* Presentation at the 2010 Constructionism Conference, Paris, France.
- Peppler, K. A., **Downton, M. P**., and Hay, K. (April, 2010). *The Nirvana Effect: Tapping rhythmic videogames to leverage learning and motivation.* Presentation at the 2010 American Education Research Association (AERA) Conference, Denver, CO.
- **Downton, M. P**., Peppler, K., and Hay, K. E. (August, 2009). *Turn That Noise Up: How Rock Band© Helps Youth Develop Rhythmic Intuitions***.** Presentation at the 2009 Society for Music, Perception and Cogntion (SMPC) Conference**,** Indianapolis, IN.
- Peppler, K., **Downton, M. P**., and Hay, K. (April, 2009). *Beyond green, red, blue, and yellow: Tracking youths' development of musical intuitions through videogame play in after-school communities*. Presentation at the 2009 American Education Research Association (AERA) Conference, San Diego, CA.
- Peppler, K., **Downton, M. P**., and Hay, K. (July, 2008). *The Nirvana Effect: Tapping the Power of Video Games to Leverage Musical Interest.*

Presentation at the 2008 Games, Learning, and Society (GLS) Conference, Madison, WI.

- **Downton, M. P**. and Bergeson-Dana, T. (October, 2007). *Effects of Music Instruction on Verbal Recall in Adults.* Presentation at the 2007 Society for Education, Psychology, and Music Research. Sheffield, UK.

Invited Presentations:

- **Downton, M. P.** 2014. The importance of taking risks when solving creative problems. Presentation at the St. John's University *Faculty Forum.* St. John's University, Queens, NY.

- **Downton, M. P.**, Peppler, K. A., and Bamberger, J. (2012). Collaborative meaning making in music: Youths' discourse during computer aided composition. Invited presentation at the 2012 National Association for Music Education (NAfME) Creativity Special Research Interest Group. St. Louis MO.

- Peppler, K. A., **Downton, M. P.**, Lindsay, E. & Hay, K. (2012). The Nirvana Effect: Tapping video games to mediate music learning and interest. Invited presentation at the Indiana University Jacobs School of Music's Music Education Research Colloquium (MERC), Bloomington IN.

Awards and Recognition:

- 2011 AERA Peace Education Special Interest Group Highest Ranked Proposal for: Pieces for peace: Using *Impromptu* to build musical and cross- cultural understanding
- 2010-2011 Treasurer-*Indiana University Learning Sciences Graduate Student Association*
- 2009-2010 Faculty Representative for Learning Sciences Students
  - Voted on by faculty of the Learning Sciences Program at Indiana University
- 2006 President, Psi-Chi – IUPUI Chapter
- 2006 Robert I. Long Award for Leadership-IUPUI
- 2005 to 2007 Deans List-Indiana University-Purdue University, Indianapolis (IUPUI)
- 2004 Honors-IUPUI

Community Service and Outreach:

- 2007-present Volunteer at the Boys and Girls Club of Bloomington
- 2011-present Webmaster for AERA Peace Education Special Interest Group
- 2011-present Board member – AERA Peace Education Special Interest Group

Professional Organizations:

- AERA-Division C
  - *Member since 2007*

- International Society of the Learning Sciences
  - *Member since 2007*

- The National Organization for Music Education (MENC)
  - *Member since 2007*

- Technology for Music Education (TI:ME)
  - *Member since 2010*

- Psi-Chi – National Honors Society in Psychology
  - *President – IUPUI Chapter 2006-2007*
  - *Member since 2005*

- Society of Music Perception and Cognition
  - *Member since 2006*